WONDERS IN WOOD

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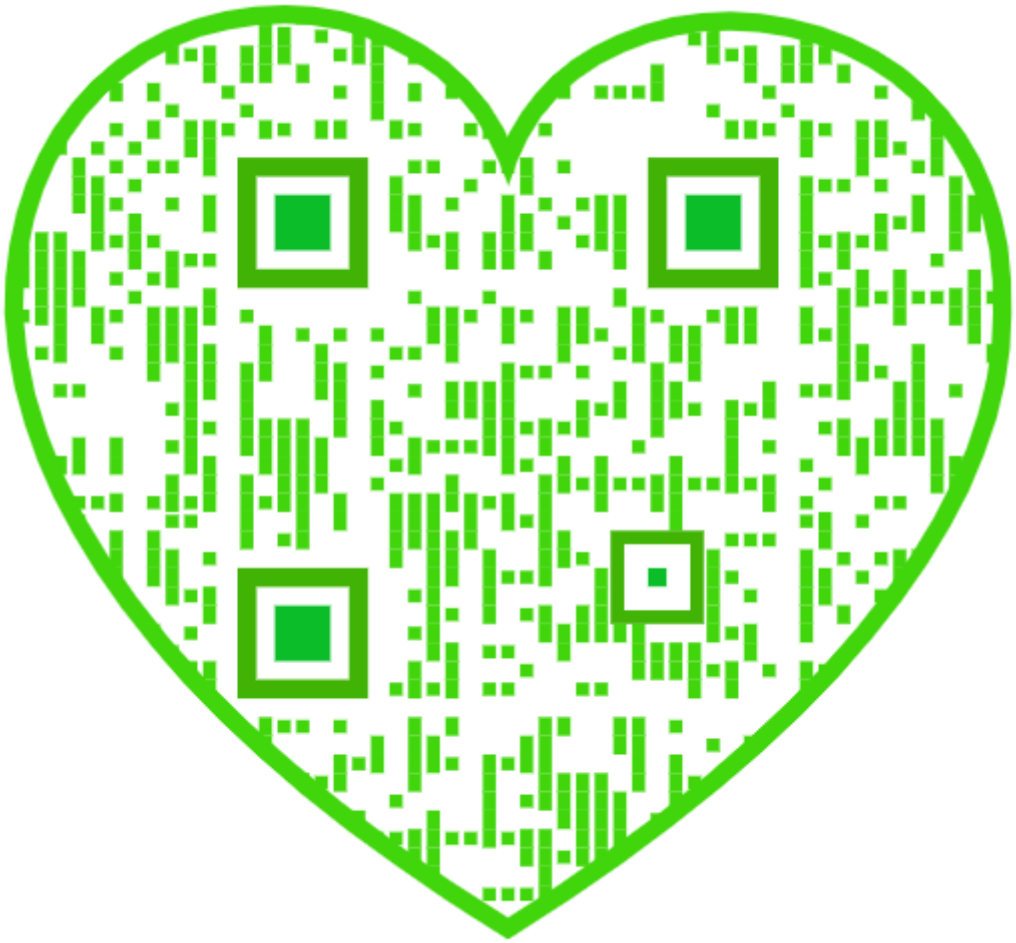
LINDEN PUBLISHING INC.
336 W. BEDFORD, SUITE 107 • FRESNO, CA 93711



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By

Edwin Mather Wyatt, B.S., M.S.

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ISBN: 0-941936-40-6

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Library of Congress Cataloging in Publication Information

Library of Congress Cataloging-in-Publication Data

Wyatt, Edwin Mather.
Wonders in wood / Edwin Mather Wyatt. – 1st Linden ed.
p. cm.
Originally published: Milwaukee : Bruce Pub. Co., c1946.
Includes index.
ISBN 0-941936-40-6
1. Wooden toy making. 2. Puzzles. I. Title.
TT174.5.W6W95 1997
745.592–dc21 97-11137
CIP

Originally published 1946
First Linden edition 1997.
© 1946 E.M. Wyatt
Printed in the United States of America

LINDEN PUBLISHING INC.
336 W. Bedford, Suite 107 • Fresno, CA 93711
1-800-345-4447
www.lindenpub.com

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WONDERS IN WOOD

by Edwin Mather Wyatt

Introduction to 1997 Printing

In this book, Edwin Wyatt presents a selection of fascinating puzzles, curiosities and woodworking projects. These classic designs originated in an era when simple amusements were more commonly embraced. Perhaps the inventors sought to stimulate a child's developing problem solving abilities, amuse the family, or simply mystify a friend. But whatever the original intent, they have left a lasting legacy for all of us to enjoy. And a number of these designs went on to become commercial successes, providing entertainment for millions.

Why is it that puzzles have held such universal appeal for so many years? Doesn't day to day life pose enough challenges, mysteries and frustration? Possibly the answer to the first question is contained in the second. Just as physical activity and exercise tones our muscles and makes our bodies more fit for our daily activities, solving puzzles sharpens our mental processes and helps us develop structured approaches to the many problems, large and small, we encounter in our lives.

Puzzles offer us the chance to achieve a gratifying "AHA!" experience; we feel clever, proud, and even superior when we solve them. Yet, because they are only toys, after all, we can readily handle the less-than-crushing letdown of having to lay them aside when the solution eludes us. Simply, for most of us, puzzles are enjoyable mental calisthenics.

And for those with some basic tools and an interest in woodworking, these pages contain much more - dozens of "one evening" projects, ideas for gifts that will please nearly anyone, a great use for those little wood scraps or off cuts in the shop that are somehow too good to discard, and a wonderful way to refine woodworking skills.

"Wonders in Wood" was originally published just as television made its appearance as the newest rage in home entertainment. It is hoped that this republication, some fifty years later, will awaken a dormant interest, anesthetized by TV, in the simple pleasures of making and solving classic wooden puzzles.

Allan J. Boardman
Woodland Hills, CA
April, 1997

INTRODUCTION

In the introduction to the author's book PUZZLES IN WOOD, he invited contributions from readers for a possible future revision of the work. The response has been so generous as to furnish most of the material for another booklet that should prove even more generously received than the first.

The first book PUZZLES was written mainly for industrial arts instructors but it has been found that many thousands of its users have been home craftsmen. With these individuals in mind, many projects have been included in WONDERS IN WOOD that may be new to such craftsmen.

Puzzles also have become interesting pastime for convalescents and have been used as a standard prescription for many both for solving and for constructing.

It is hoped that WONDERS IN WOOD will be found equally as stimulating as its predecessor, and that the users of this booklet will get as much pleasure out of solving and constructing the projects as the author has had.

Although frequently the same idea for a project has been contributed by several readers, or someone has called attention to well-known material with no claim as its originator, credit is given to the contributor of a project, wherever it seems justified, as follows:

Built-Up Square by A. W. Phillips, Sequoia North Park, California.

Cut-Up Checkerboard, and *Enchanted Dice* by Dr. L. K. Hallock, Jacksonville, Illinois.

Double Cross, Double-Double Dovetail Joint, and *Tetrahedron or Triangular Pyramid* by Mortimer H. O'Connor, Harrisburg, Pennsylvania.

Eighteen-Piece Double Cross, Floating Magnet, and *Quadruple Burr* by Thomas Thomason, Astoria, Oregon.

E Puzzle by Harold J. Kittsley, Cedarburg, Wisconsin.

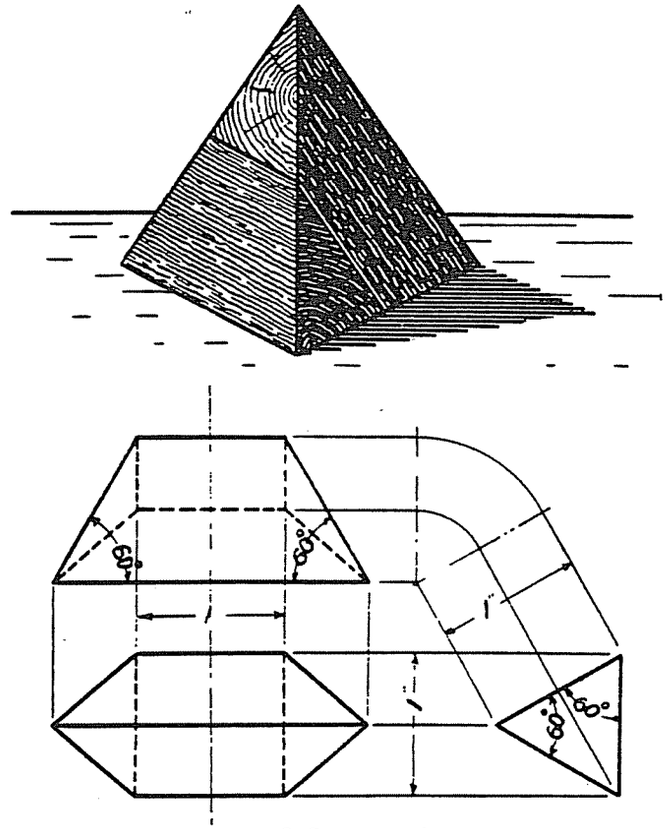
Lost Area by E. B. Escott, Oak Park, Illinois.

Mysterious Block by Robert E. Rice, Houston, Texas.

Snowflake by Clyde E. Wilson, Ft. Morgan, Colorado.

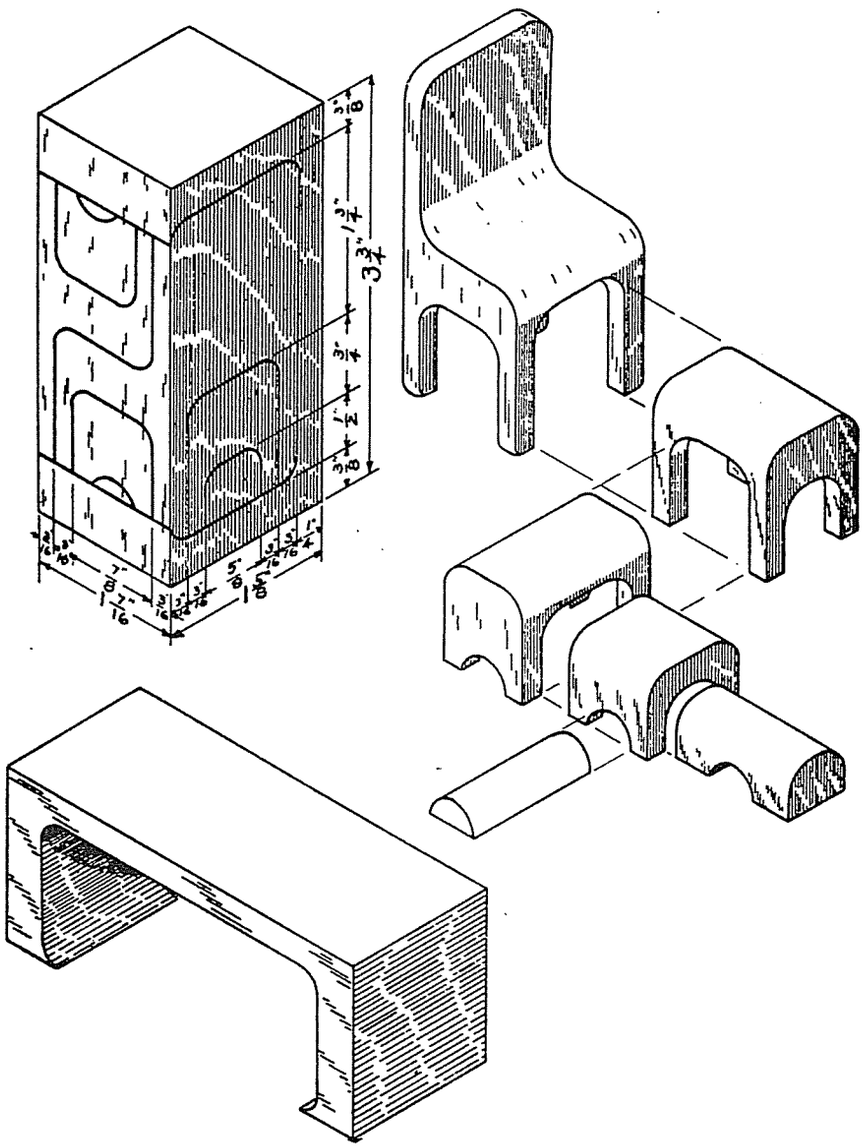
THE TETRAHEDRON OR TRIANGULAR PYRAMID

A fit-together puzzle of but two like pieces would seem too simple to challenge the interest of anyone but a child. The apparent simplicity of this puzzle, however, is quickly destroyed after many minutes have been spent by self-confident individuals



2 Required

Tetrahedron or Triangular Pyramid



Nest of Toys

in seeking the solution. It is a safe bet that it will not be assembled in seconds nor without many trials and errors. There seems to be some suggestion in the grain of the wood that leads to the assumption that this grain should not be crossed to build such a mathematically perfect figure as the tetrahedron.

The craftsman who takes pride in having his work fit snugly, with mathematical accuracy, will find quite a challenge to his skill when he tries to make two of these little blocks that measure up to his ideals. All the necessary dimensions and angles are given in the working drawing.

The author has seen a four-piece modification of this project by cutting the piece as drawn here on the center line. It is good either way.

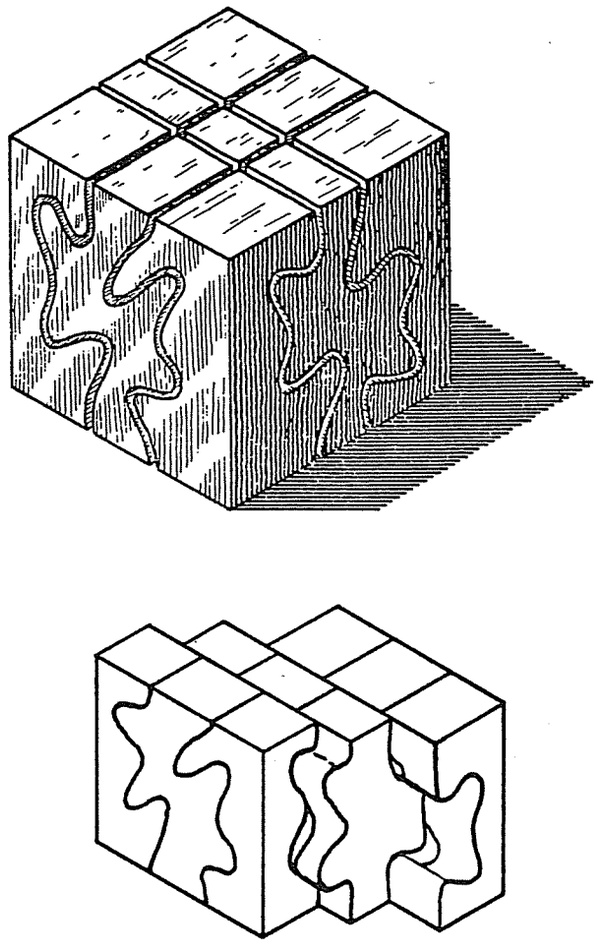
NEST OF TOYS

This is a nest of thirteen pieces of doll-house furniture band-sawed from a rectangular block of wood. It makes a striking demonstration of what can be done on a small band saw, or a jig saw, mounted with a fine blade, and can be counted on to hold anyone's attention until every piece has been sawed out. The dimensions may have to be modified to fit the saw blade available. Of course, a firm, close-grained wood, like cherry, magnolia, or birch, should be used.

A THREE-DIMENSION JIGSAW PUZZLE

This is an interesting variation of the conventional jigsaw puzzle. It is made by jig-sawing a cube from two directions with weaving kerfs which hold the pieces together even after the kerfs have been cut.

The four kerfs are sawed before removing any part of the cube. If the kerfs hold the parts dovetailed, the cube can be assembled only by putting it together in three groups of three parts as shown in the lower illustration. It cannot be assembled,



Three-Dimension Jigsaw Puzzle

like the ordinary jigsaw puzzle, by placing any pieces that fit as they come to hand.

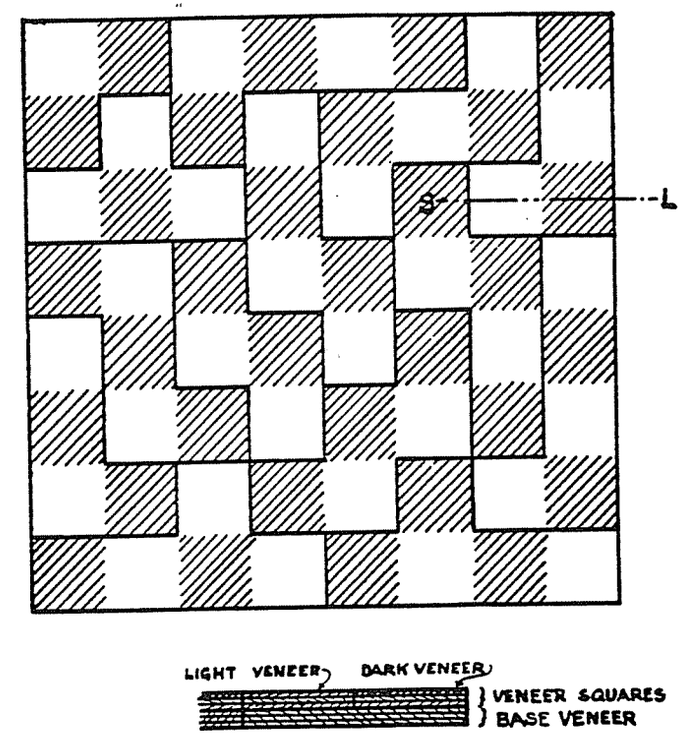
The size of the cube to be cut will be determined by the kind of saw used to cut the curves. If it is to be cut by a fine jeweler's saw, the cube might be ¾ in., but if a large band saw is to be used, the cube may be 3 in. in size A little experimenting on a scrap of wood will determine the minimum size of cube.

CUT-UP CHECKERBOARD

Cut-up checkerboards are old puzzles, but this one has more than the usual number of solutions. The author has been assured that there are at least a hundred known solutions, enough to furnish many hours of entertainment.

The most satisfactory checkerboards, especially those which are to be cut up as this one is, are constructed of plywood. Boards made of plywood will not shrink or swell like boards built up of squares cut from solid lumber.

The squares should be cut from three-ply and the base from five-ply plywood. If contrasting colored plywood is not available for the squares, half of them can be stained before gluing.

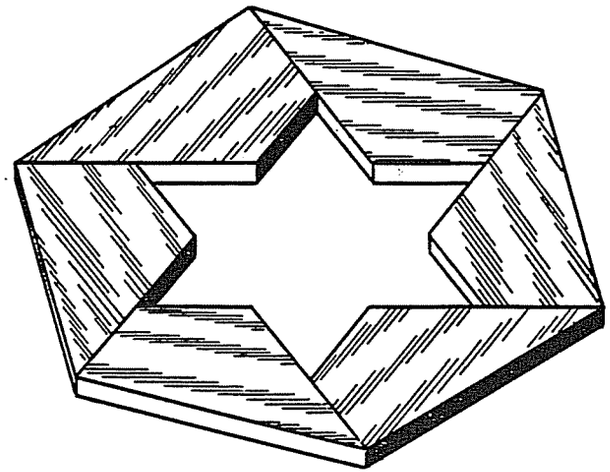


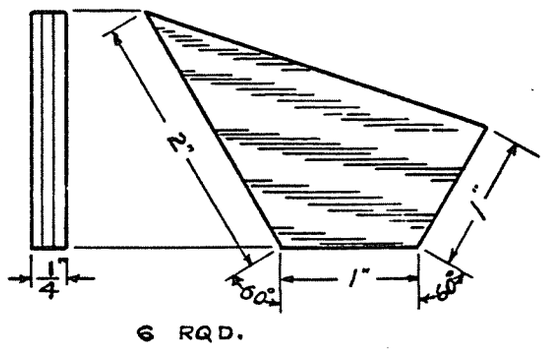
Cut-up Checkerboard

SIX-POINTED STAR

Give someone six identical pieces of plywood as shown in detailed form in the drawing, and it is surprising with what confidence he will begin to build a six-pointed star as directed. But it will be a surprise to the worker when he realizes the length of time it will take him to build the star.

So far as the author knows, this is his contribution to the world's entertainment, although he has seen a puzzle similar to this one for a five-pointed star.

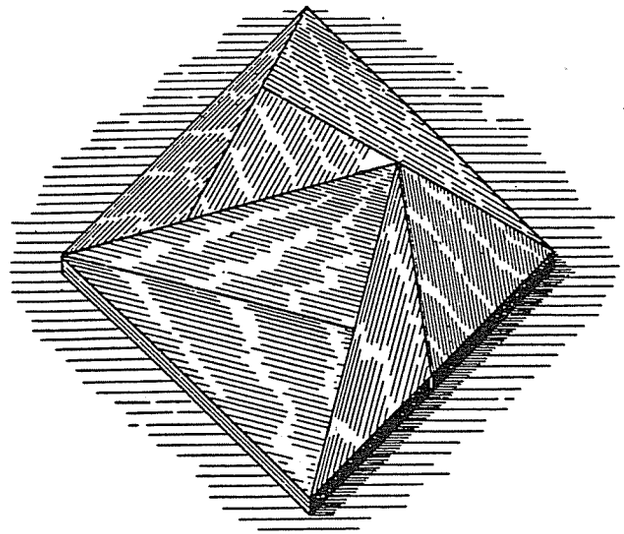


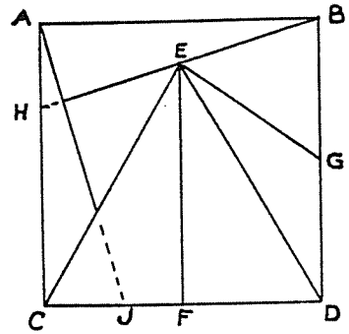


Six-Pointed Star

SQUARING TRIANGLES

This cut-up puzzle is not easily solved when made of cardboard. However, when made of wood with its grain to lead one astray, it becomes an even more difficult puzzle. The cue in solving this puzzle is to select the two triangles which together make up an equilateral triangle, and build the others around it. Of course, this equilateral triangle can be turned at will, as comparison of the two drawings will make clear.





CONSTRUCTION PROPORTIONS

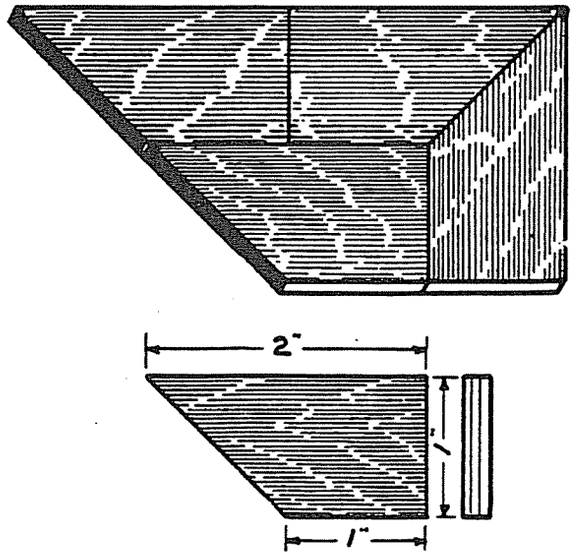
AB=CD=AC=BD=CE=ED
BG=GD=DF=FC
LOCATE H BY EXTENDING BE.
MAKE CJ=AH.

Squaring Triangles

The easiest way to make this puzzle is with the use of cardboard templates. First, a square should be drawn on cardboard and then the parts should be laid out according to the formula included with the drawings. The square then should be cut up into the several parts and each part used as a pattern for planing or sawing out the wooden parts.

BUILT-UP TRAPEZOID

People who like built-up puzzles will like this one which is made up of four identical trapezoids to be built up into a larger one of the same shape and proportions. The solution of this puzzle is simple enough if the drawing is on hand, but it will take time and effort to find the correct answer without this illustration.

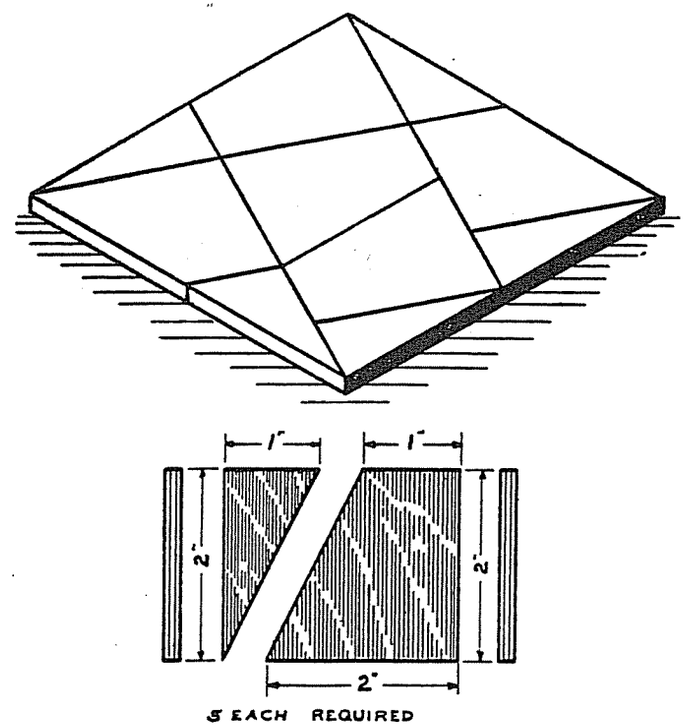


Built-Up Trapezoid

BUILT-UP SQUARE

Without the help of the solution shown in the drawing, most readers will find it takes many attempts before a square can be built of the ten pieces called for in the detail drawings. Try it on someone who has not seen the solution and become convinced.

A variation of this puzzle can be made by building the same square from twenty of the triangular pieces. That it can be done with only the triangles is evident from the fact that the larger piece in the detail drawing has the shape of three triangles combined.

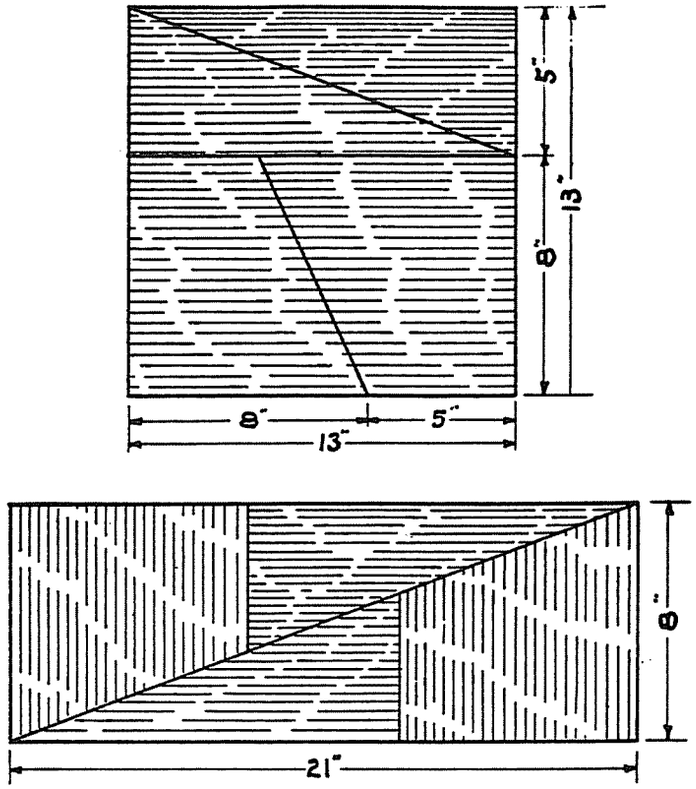


Built-Up Square

LOST AREA

If the 13 by 13-inch piece of plywood in the upper drawing is cut into four pieces as shown, it is quite evident that these pieces can be rearranged into the 8 by 21-inch rectangle in the lower drawing. Sure? But the areas do not agree, for 13 by 13 equals 169, and 8 by 21 equals 168. Maybe the author's arithmetic is wrong.

A similar puzzle appeared in the author's *Puzzles in Wood* in which an 8 by 8-inch block is cut in the same manner and is rearranged to 5 by 13 inches, thereby gaining a square inch of area.



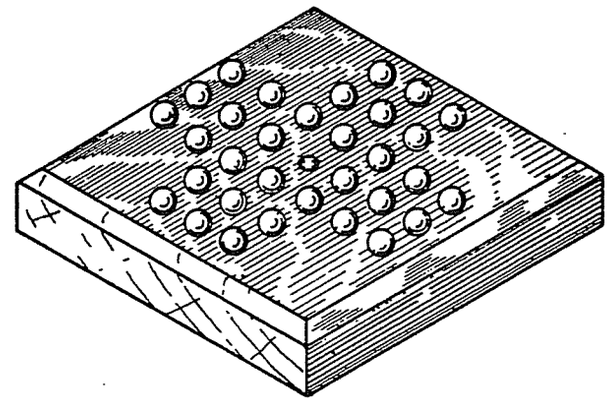
Lost Area

SOLITAIRE MARBLE GAME BOARD

The objective in this game is to jump and remove the jumped marbles, as in checkers, until but one marble is left and it is in the center hole. It is a modification of the quite common pegboard. Marbles used in the familiar Chinese checker game are suitable, because it is not necessary that the marbles are all of one color. The size of the holes and, in fact, the entire dimensions of the board will depend on the size of the marbles available.

If the holes are placed 1 inch on center, a convenient over-all size for the board will be 9½ by 9½ inches.

To prove that the objective can be attained, a solution is given on the drawing worked out step by step.



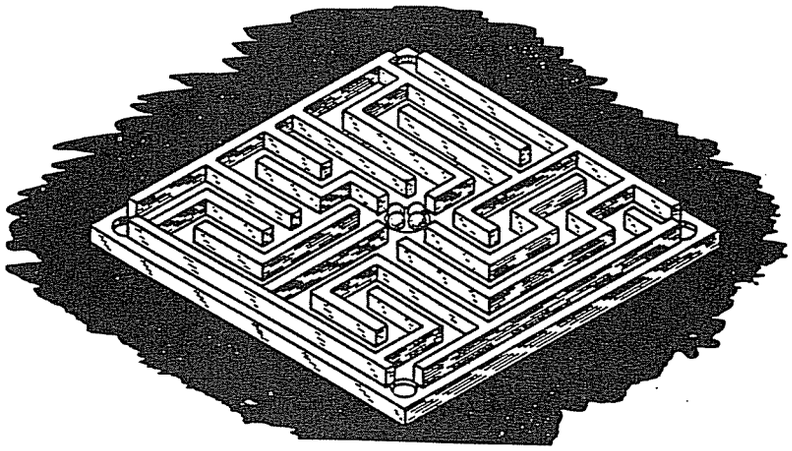
	A	B	C	D	E	F	G
1			o	o	o		
2			o	o	o		
3	o	o	o	o	o	o	o
4	o	o	o	o	o	o	o
5	o	o	o	o	o	o	o
6			o	o	o		
7			o	o	o		

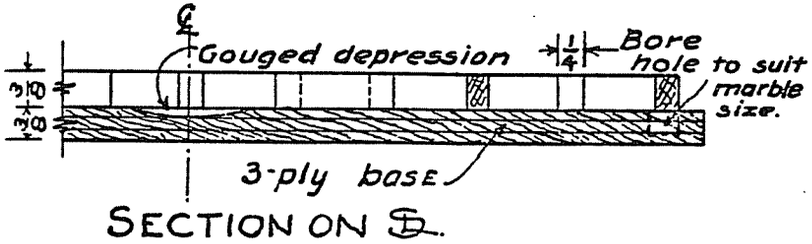
IDENTIFICATION KEY

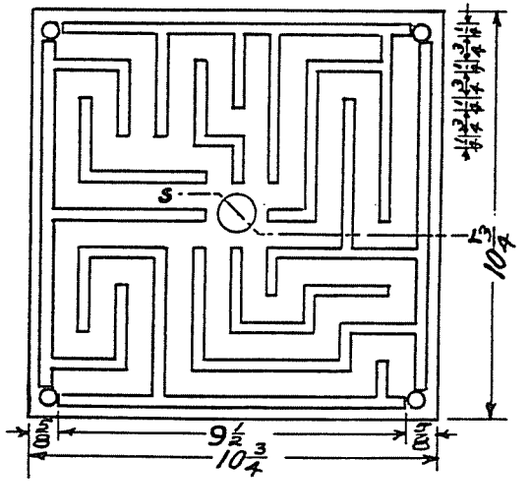
A SOLUTION

D6	D4	B5	D5	D3	B3	E4	C4
D3	D5	C7	C5	A3	C3	C4	C2
F3	D3	E7	C7	C4	C2	C1	C3
E5	E3	C4	C6	E6	E4	D5	B5
G5	E5	C7	C5	C1	C3	B5	B3
D5	F5	C2	C4	E1	C1	B3	D3
G3	G5	A3	C3	F4	D4	D2	D4
G5	E5	A5	A3	E2	E4		

Solitaire Marble Game Board







Marbles in a Maze

MARBLES IN A MAZE

When someone explained to a physician how the maze board is tipped in different ways until the four marbles in the center are rolled into the holes at the corners, he expressed professional interest in its suitability for entertainment of convalescent patients. But when he tried the medicine on himself he exclaimed, "No, this would only transfer patients from the convalescent ward to the psychopathic ward!" So, unless you can stand mental strain, try this only on the other fellow.

The walls between the rollways are wooden strips which are glued and bradded to a plywood base. An infinite variety of mazes can be worked out on a sheet of section-ruled paper, but the one illustrated is good.

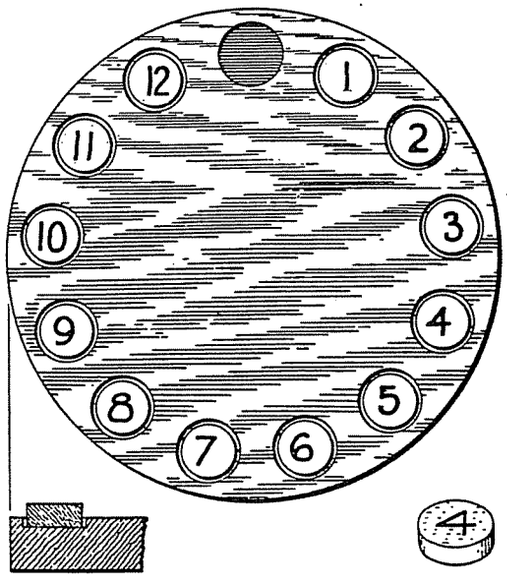
SOLITAIRE CHECKERBOARD

The shut-in or convalescent who must entertain himself will find the solitaire checkerboard quite a friend. The rules for playing the game are simple:

1. The clockwise arrangement of the numbered checkers is to be changed to counterclockwise by moves and jumps as in checkers.
2. Jumps or moves can be in either direction.
3. Moves can be only to the adjacent vacant hole.
4. Jumps can be only over one checker.
5. Jumped checkers are not removed.
6. The fewer the plays the better the score.

If you finish the game the first time in less than 100 plays you have done very well, but it can be done in less than half that number.

If the board is made of wood, as called for in the drawing, a Forstner bit having no spur is the tool to use for boring the holes. A set of numeral stamping dies is ideal for marking the checkers. The depressions from these stamps can be filled with paint or white lead. The checkers can be cut from a circular dowel. If the numbers are stamped on the end of the dowel before the checkers are cut off, it will save breaking many of them.



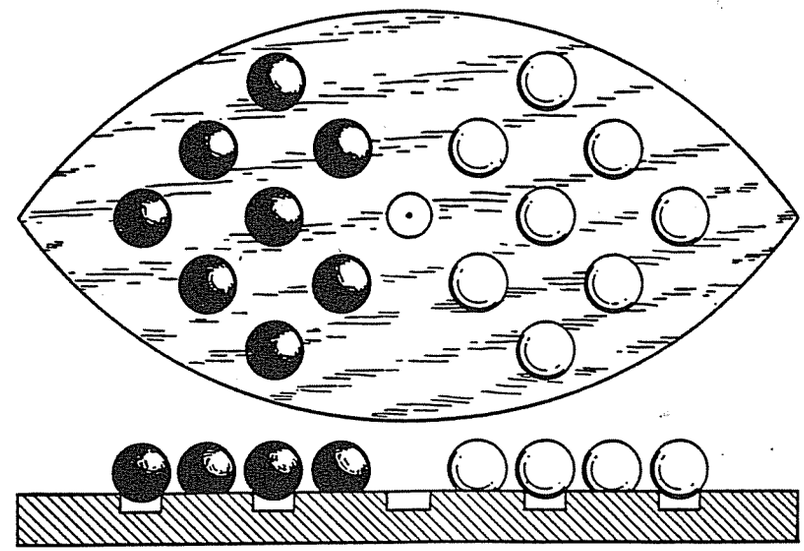
Solitaire Checkerboard

Dimensions for the board and the holes for the checkers will depend upon the size of the checkers. If ¾-inch dowel is available, the diameter of the holes should be ⅞ inch and the board about 7½ inches.

If wood is not obtainable, there is no reason why the board and checkers cannot be made of cardboard. Cardboard, pencil, and shears are really all that are necessary to make many entertaining games of checker solitaire.

FORE AND AFT

This puzzle can be worked in several ways. The best game, however, is the one with the fewest moves. Most individuals will play it many times before finding the quickest solution, and then that may not be the best.



Fore and Aft

Following are the rules for playing the game:

1. The positions of light and dark marbles should be transposed with as few moves or jumps as possible.
2. Marbles should be moved, one at a time, in diagonal moves forward similar to checkers, and no backing up or straight forward or straight crossways moves are permitted.
3. Moves or jumps need not be alternately black and white.
4. Jumping of a single man, as in checkers, is considered a move and may be over the same or a different colored man.

The first part of the puzzle is to make as many moves as possible without getting cornered or violating the rules.

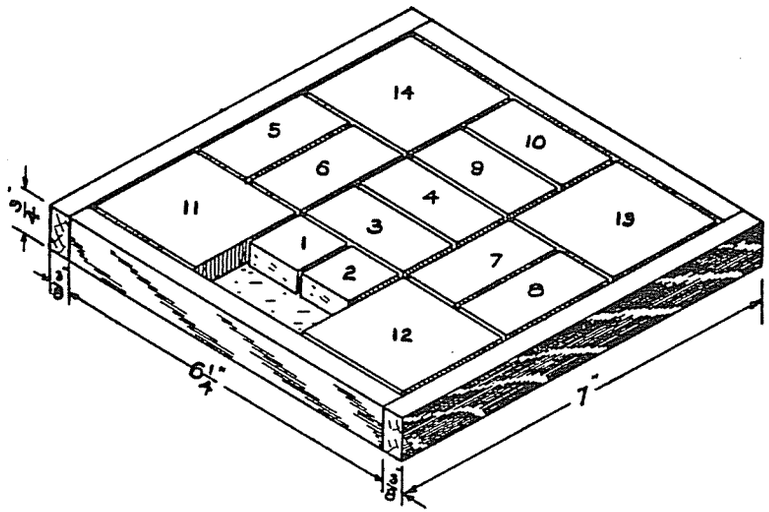
After the player learns to keep out of corners, he should see how few moves are essential for the transposition. Anyone can learn to play the game in less than a hundred moves and jumps, but it can be done with less than half that number.

The dimensions for the board and holes are not given, for they will depend upon the size of marbles that are available. The board sometimes is made with small holes for pegs instead of holes to fit marbles.

SHUFFLE BOX NUMBER ONE

This game of solitaire will take hours to work the first time because so many wrong moves are possible. The game is to shuffle the blocks about without removing them from the box so that a large corner block is moved from one corner to the opposite one. The author has recorded the steps of moving block 14 to the corner occupied by 12 but is not sure that he has worked out the fewest moves. He merely records his procedure to show it can be done.

Place the blocks in the box so that the blank space is at the bottom in the center. The letters R, L, U, and D in the following solution indicate respectively *right, left, up,* and *down.* Thus 1 D and R indicates that block 1 should be moved down and right, and 3 and 4 L indicates that blocks 3 and 4 are moved together to the left. The moves should be read down the several columns as follows:



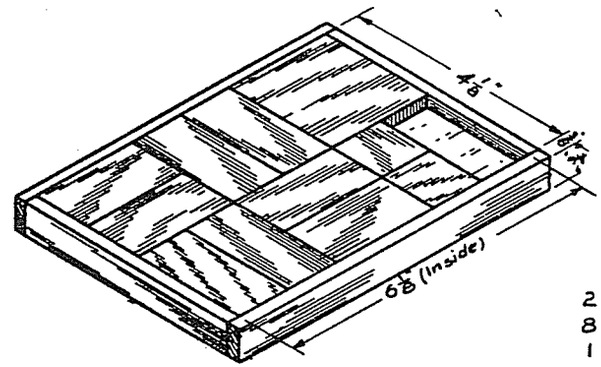
2 blocks 3/8" x 1" x 1"
8 " 3/8" x 1" x 2"
4 " 3/8" x 2" x 2"

Shuffle Box No. 1

1 D and R	9 L	2 L and D
11 R	2 U and L	14 D
5 D	13 L	3 L
6, 3, and 4 L	8 U	4 and 12 U
2 and 1 U	7, 3, and 4 R	1 and 2 R
11 and 5 R	1 and 2 D	14 D
6 D	13 and 8 L	3 D
3 and 4 L	7 U	4 L
1 L and U	3, 4, 1, 2, and 14 R	12 U
3 R	6 U	2 U and R
4 and 14 D	5 and 11 L	11 and 14 D
10 L	1 and 2 D	5 D
9, 1, 2, and 3 U	14 and 6 R	6, 3, 4, and 12 R
4 R	5 U	1 and 2 U
14 and 10 D	11 L	14 R

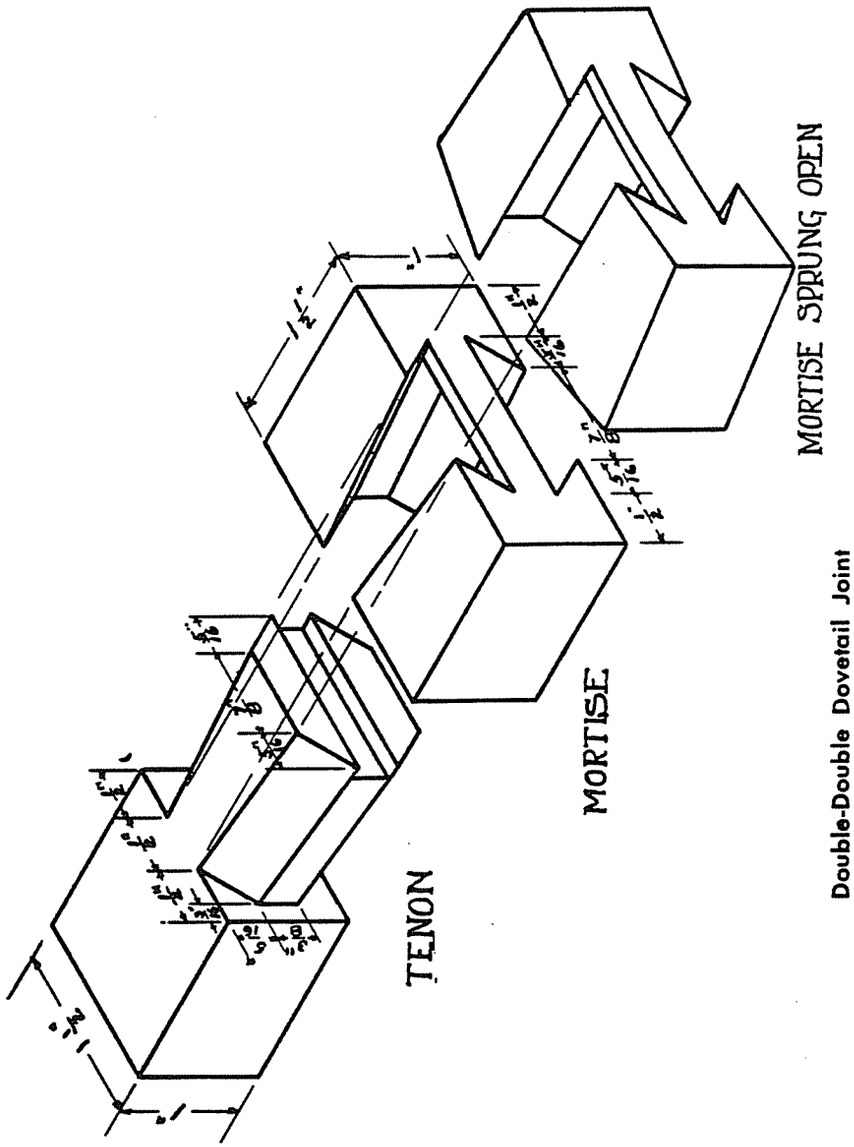
SHUFFLE BOX NUMBER TWO

This is another shuffle box, but with only eleven blocks. In this, the problem is to move the large square block to the diagonally opposite corner, without removing any blocks from the box. Don't write the author for the answer for he hasn't found it yet, but he has been assured that it is an old well-known entertainer.

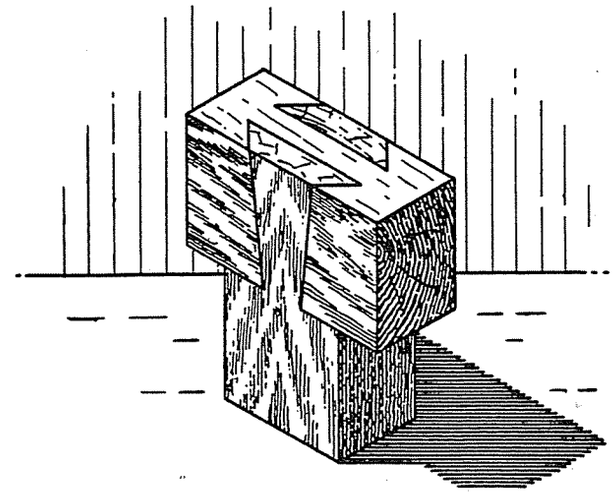


2 blocks 3/8" x 1" x 1"
8 " 3/8" x 1" x 2"
1 " 3/8" x 2" x 2"

Shuffle Box No. 2



Double-Double Dovetail Joint



DOUBLE-DOUBLE DOVETAIL JOINT

Those who are familiar with the author's *Puzzles in Wood* can likely explain how to assemble a single dovetail that is larger on two outside faces than the spaces through which the tenon must pass in going into place. Knowing the right answer to that puzzling construction, however, only adds to one's bewilderment when trying to figure out how to put together a dovetail joint with a duplicate tenon on the opposite side. This second tenon makes impossible the diagonal sliding together used on the double dovetail. Yet how simple it all is when one studies the detail drawing.

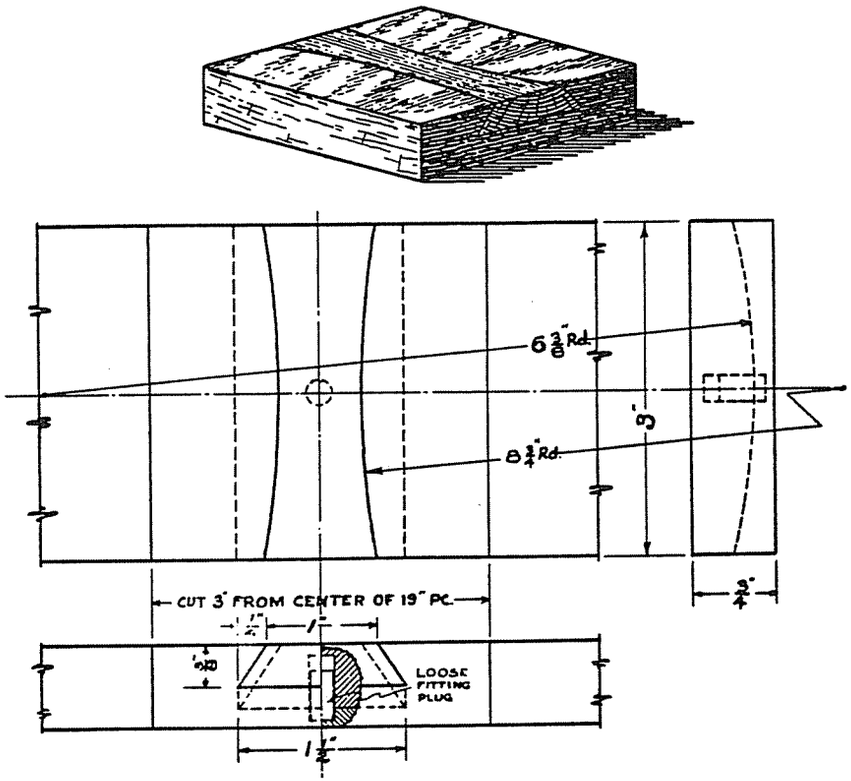
Enough dimensions have been given to help plan a joint to suit material on hand. There is some advantage in making the sloping sides of the dovetail at an angle of 60 deg., or pitch of 2:1, instead of 45 deg. as shown — it widens the angle one has to work into. Of course, the connecting bar of the mortise must be made thin enough to be able to stand considerable bending when the mortise is spread open for the insertion of the tenon. The mortise may be steamed to increase its flexibility, if necessary.

This is more a puzzle novelty joint than a rival for the old tried and true mortise and tenon or simple dovetail. Its maker will not lose in reputation, however, just because it is impractical.

TRIPLE DOVETAIL PUZZLE

If one does not believe that in this puzzle one piece of wood extends through another so that it shows on three faces and is held in by impossible dovetailing from all sides, he should feel of the combined piece and find that the two pieces can be moved slightly. The fact that the pieces can be moved, however, may only add to his confusion. If the maker of the dovetail places a mark on both pieces, and then later proves that both pieces have been reversed, it will confuse the one who is trying to solve the puzzle even more.

Study of the working drawing will show that the dovetail is unusual only in that it is curved and not straight, and that the



Triple Dovetail Puzzle

tenon slides into the mortise or groove with a rocking movement instead of a straight one, as usual.

In making this puzzle, the most careful workmanship is required and strict adherence to dimensions as given in the drawing or as worked out on a drawing board.

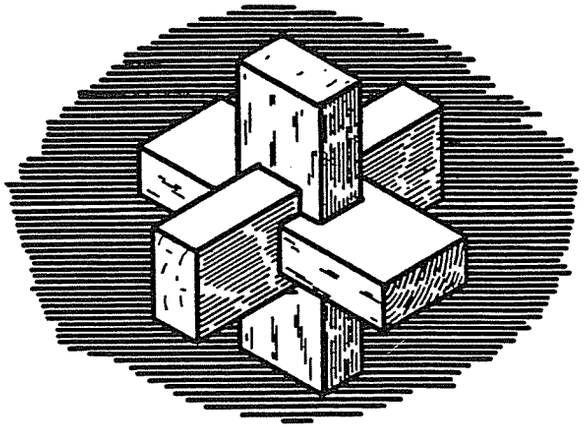
Both the mortise and the tenon should be laid out from carefully scribed center lines on wood longer than the dimensions given. Carefully laid out templates should be used for the 2:3 pitch dovetails and for the 6⅜-inch radii. The tenon should be made first and used for testing as the mortise is being carved out. The bored holes for the peg should be carefully centered so that the pieces will fit by placing the tenon into the mortise either way. The grain direction shown in the perspective should be observed. Contrasting colored woods make the apparently impossible dovetailing all the more striking.

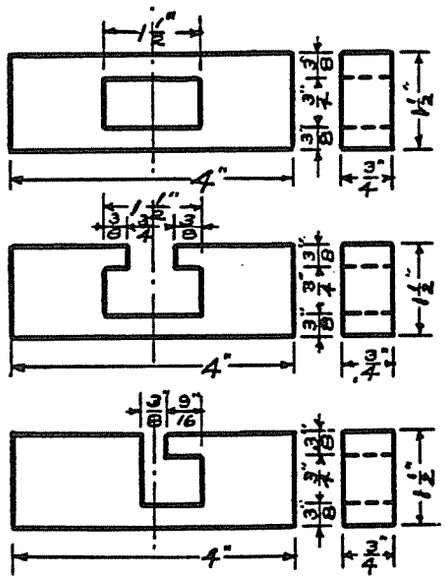
The idea for this construction came from a puzzle joint published in the *Industrial Arts and Vocational Education* magazine by A. B. Cutler, January, 1930. The little peg that locks the joint in place when it is held dovetail-side up and drops back to release the pieces when turned over has been added by the author.

DOUBLE CROSS

This makes quite a striking project when constructed of three contrasting colored woods. It is an interesting puzzle to put together for anyone not familiar with wood puzzles.

A similar construction is shown in the author's *Puzzles in Wood,* but the shaping of those pieces is more complicated than the ones shown here.

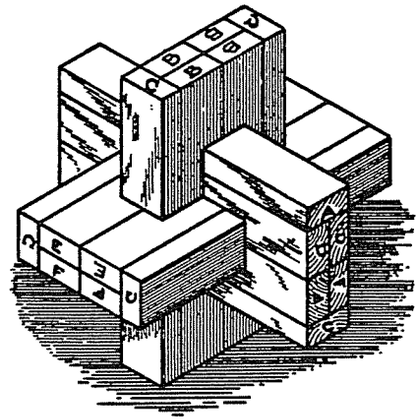


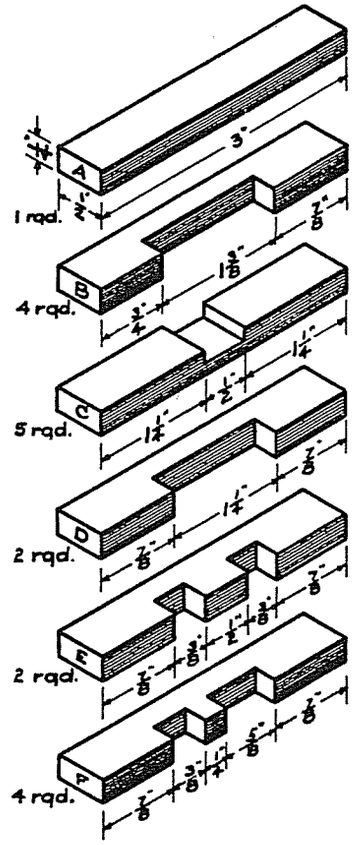


Double Cross

EIGHTEEN-PIECE DOUBLE CROSS

The author knows of many ways in which to make six-piece burrs, carpenter's knots, or double crosses, or whatever one prefers to call them. These are all intricately notched pieces of wood. The cross shown here, however, has eighteen pieces. The sample sent to the author looked like it consisted of twice that number, for each piece had been scored along the middle of the sides and ends with a marking gauge so that each piece appeared as two pieces. It is suggested that the pieces be marked that way, although the drawing is shown, for simplicity, without that embellishment.





Eighteen-Piece Double Cross

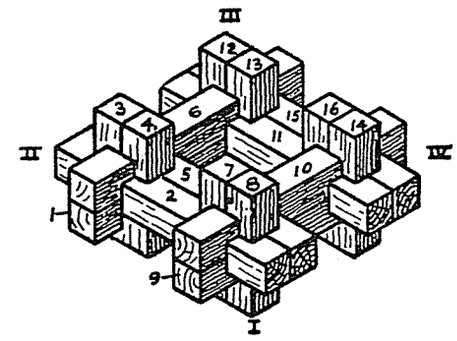
As a help in putting this puzzle together, each piece has been located in the assembly by its identifying letter turned exactly as it has been drawn on the detail of the piece. It will be difficult enough to put together even with this help.

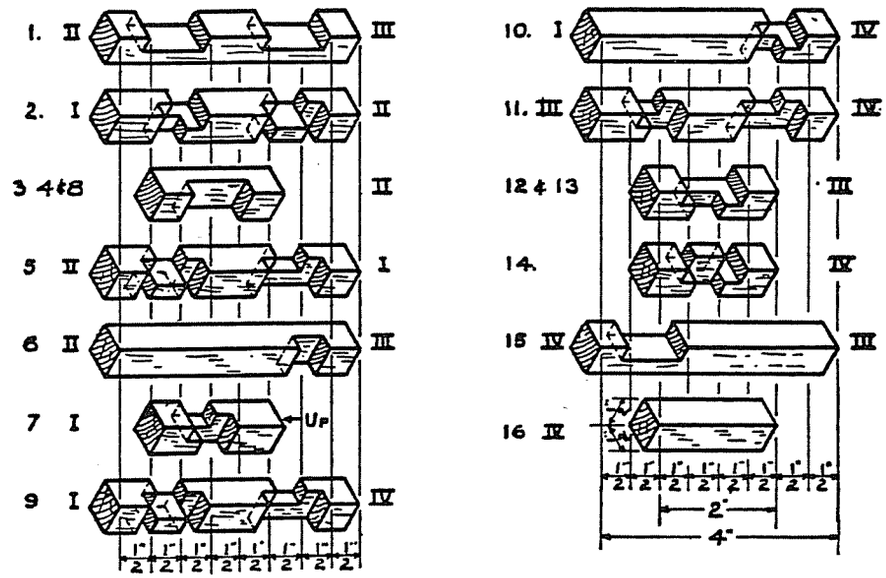
QUADRUPLE BURR

Fundamentally, this consists of four simple six-piece burrs. It is possible to combine these by making a number of the pieces double length. The puzzle could be built of most of the score or more known designs for such burrs. However, this project is a little complicated, for a real problem arises in assembling the fourth burr. In the detailed drawing, this assembly problem is solved as follows. A burr design with a blank key is used as the final piece, and the order of building up is so arranged that the final piece to be put in at each corner burr is a plain uncut piece. Assembling the pieces with a planned place for this final key will be a great help in building up the complete burr.

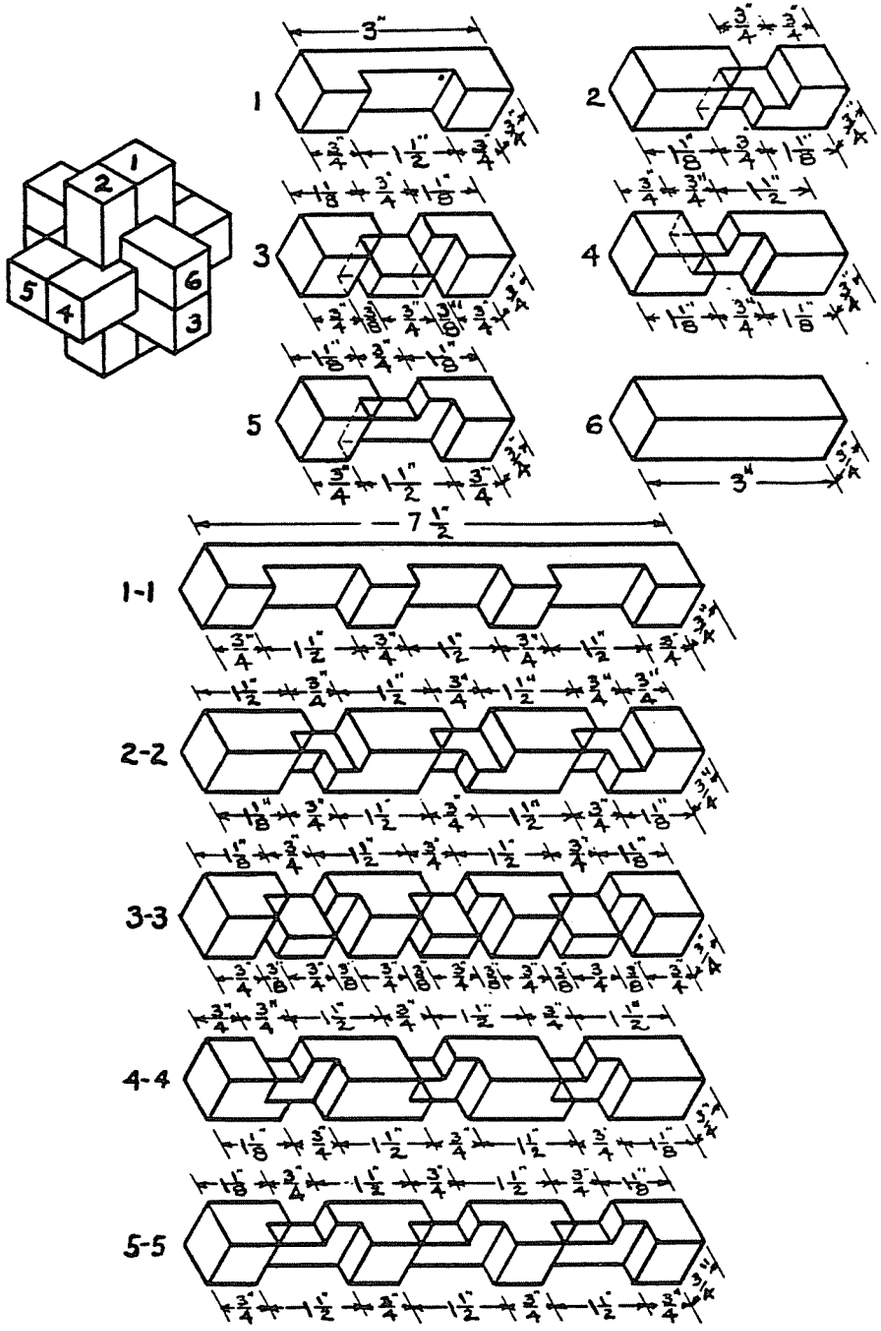
The pieces should be assembled in the 1, 2, 3 order, as numbered. The I, II, III, and IV ends should be observed and placed into corresponding burrs. The pieces and corners should be chalked to keep them in order the first time. Assembling the burr will be difficult enough without getting the corners mixed up.

The author suggests that the short pieces also could be made double in length and an eight-burr assembly then could be built by an adventurous puzzler.

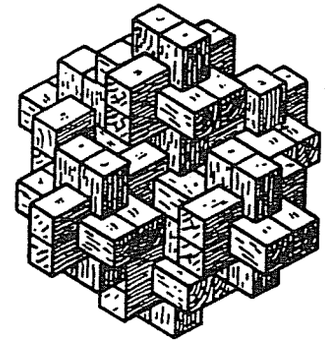




Quadruple Burr



The Snowflake



THE SNOWFLAKE

Anyone familiar with the crystalline form of a snowflake will recognize the propriety of the name selected for this beautiful burr. It is really a build-up of seven six-piece burrs. Many of the burrs in the author's *Puzzles in Wood* could be used for this project. The snowflake is made up of four each of pieces 1 to 6 inclusive, and one each of pieces 1-1 to 5-5, with a plain key piece ¾ by ¾ by 7½ inches, not illustrated, which would be piece 6-6.

Learning to assemble the six-piece burr shown at the left in the drawing will help one to assemble the snowflake. It is made up of one piece each of 1 to 6, and it is assembled in 1, 2, 3 order, as shown in the small assembly. Detailed steps for assembling this burr are shown in *Puzzles in Wood,* but why spoil the fun. Find the answer. It is advisable to number each piece, because it will be difficult enough to work out the assembly without trying to keep each piece in mind. After the six-piece burr has been combined, the snowflake can be assembled by keeping corresponding pieces in each sub-assembly parallel.

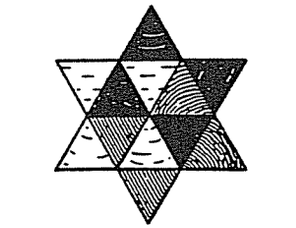


Fig. 2

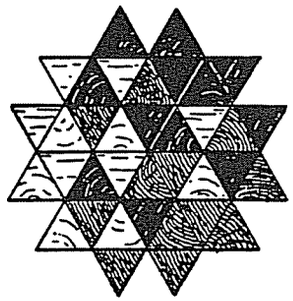
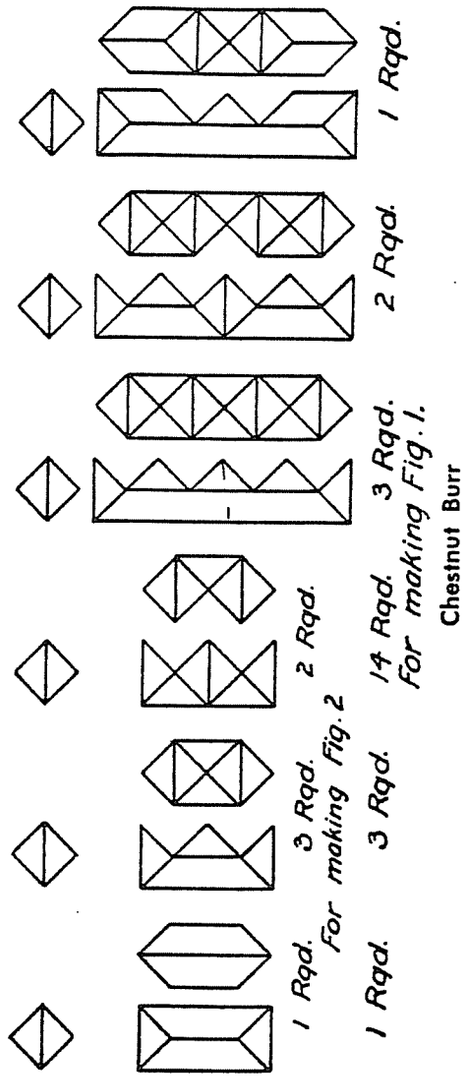


Fig. 1



Chestnut Burr

CHESTNUT BURR

This is as striking a burr as has ever come to the author's attention, and it is rivaled only by the great pagoda in *Puzzle in Wood*. It is much more attractive than an artist's pen can depict for it exposes no less than 144 triangular facets on its exterior.

It is made up of 24 pieces as shown in the drawing. The pieces are not dimensioned as they are all obviously based on the diagonal of the square stock used. All cuts are made at 45 degrees to the axis — not with the corners.

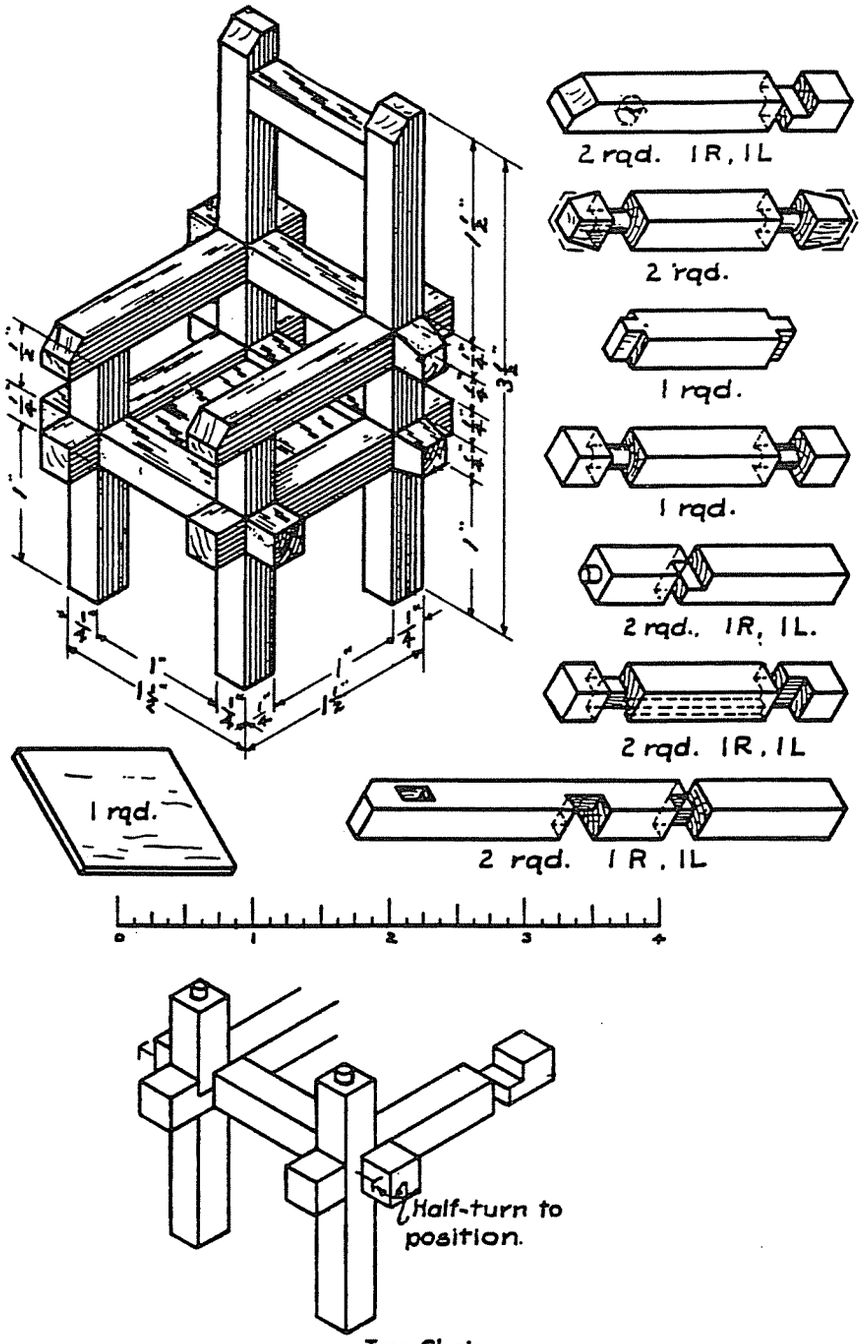
This construction requires such accuracy because of the necessity of interchangeability, that it is impractical to make the pieces with essential exactness without the use of precision machinery. Therefore, it is suggested that unless one has unlimited time, skill, and patience, the making of the burr should not be undertaken with hand tools. Anyway, it is advisable to test out the small burr in Figure 2, first.

This burr is being manufactured and sold by the Puzzle Shop, 808 Twentieth Street, Denver, Colorado, under the appropriate trade-marked name of Gem Cut Puzzle.

TOY CHAIR

Yes, it comes apart. How convenient it would be on moving day if all furniture could be taken apart, piece by piece, for packing — unless one forgot how to put it together again! Better practice a little on this toy chair on page 38 before starting a knockdown furniture factory.

The trick in assembling this chair is shown in the lower drawing. The front rail is inserted in an upside-down position before the side rails are attached. Then, after these are in place, the front rail is revolved a half turn into the position shown in the assembly drawing. The two lower back rails are inserted in the same manner. It is very necessary that these two back rails are tapered on two sides at the ends, as will become apparent when the arm rests are being swung into place.



Toy Chair

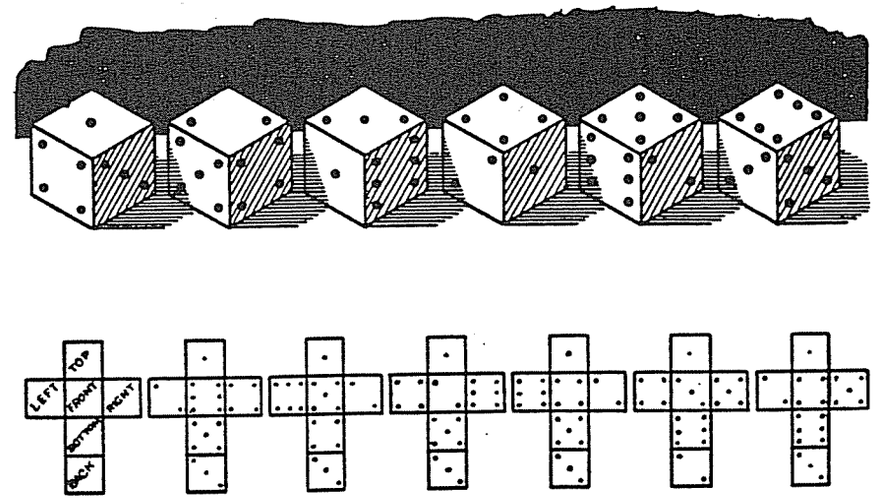
ENCHANTED DICE

Study of this row of dice will show that the numbers one to six which occur on each die are to be found on all sides of the lined-up dice; thus, one to six appear on the tops, on the right-front faces, and on the left-front faces. By turning them over, these numbers also are found on each of the other three faces as well, but on only one face in numerical order. The originator of this puzzle has figured out that there are 16,755 ways of arranging the spots on the dice to produce the described arrangement, but the author, after some experimenting, surmises that there must be a million arrangements that are not quite right.

The dice are not standard as to spotting, but must be laid out according to the lower stretchout drawings.

A good way of making these dice is to first shape the wooden cubes, spot them with brass-headed tacks, paint the entire cube, and then polish the spots off through the paint.

A variation of this wonderful puzzle by the same originator is given in *Puzzles in Wood*. Either of these puzzles will provide hours of pastime for anyone who will shuffle the dice and then try to find the answer without a chart.

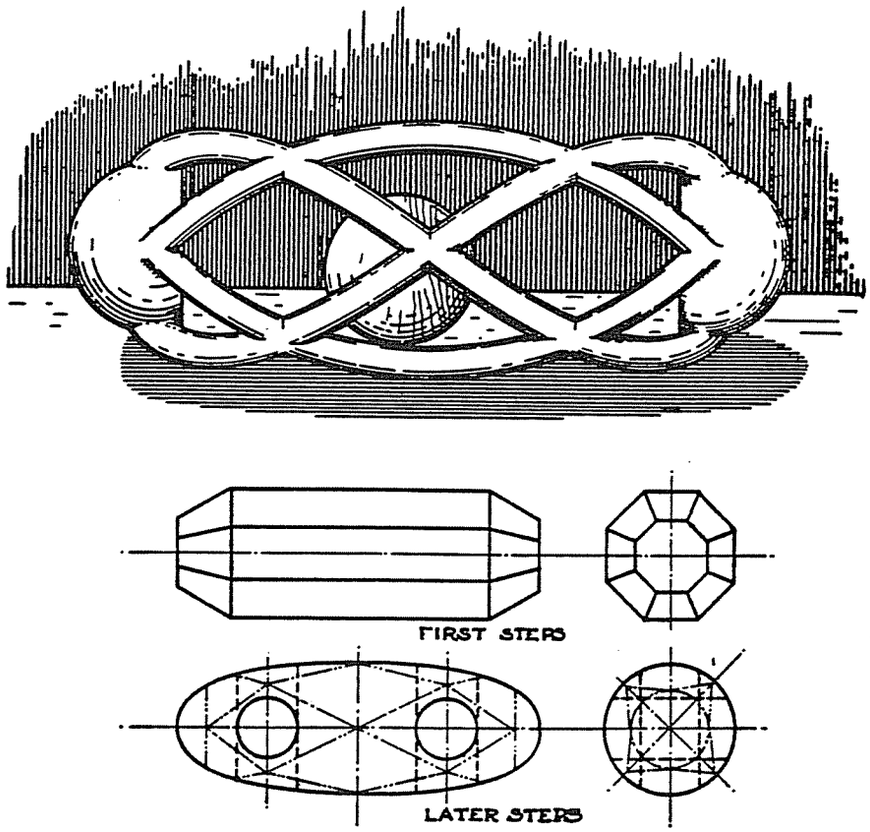


Enchanted Dice

CROSS-BARRED BALL CAGE

This is a nice idle-time busy-work project. No tools are necessary except a sharp pocketknife, a pencil, and a piece of soft white pine. A brace and bit and a carving chisel can be used to advantage, but they are far from necessary. Dimensions are not given since these must be suited to the material available. A diameter of from 1 to 2 inches, however, is a convenient size.

To insure a satisfactory result, it is important to keep the layout symmetrical. This is achieved by shaping the project in



Cross-Barred Ball Cage

steps that can be measured and checked for reasonable geometrical accuracy, as shown in the drawing for the First Steps.

After the elliptical shape has been worked out, the center lines of the bars should be laid out as shown in the Later Steps drawing, using four equally spaced points at the center and four intermediate points halfway to each end. The width of the bars can be drawn on the ellipse by using a convenient width strip of wood. The bars should be outlined with a knife or carving-tool point. If an auger is available, four crossing holes should be bored through the ellipse as shown, although a knife can be used to do all the cutting work. From now on the eye must be depended on entirely in working out the bars, undercutting them, and finally cutting out the ball inside and rounding it up. A little sandpaper and a small file are useful in smoothing the construction into workmanlike finished form.

CONCENTRIC SPHERES

A favorite oriental evidence of craftsmanship consists of a number of ivory-ball cages made concentric so that the smallest is within all the others and the largest covers all of them. Each is a perfect sphere and is cut clear of its neighbors. Anyone with imagination and familiar with how the task must have been done will be sure to appreciate the skill such a cluster shows (page 42).

Most anyone will be content to make a sphere of inexpensive wood with a single ball within as evidence of his patience and skill — at least as a beginner.

The first step is to make the outside ball by chucking it on a lathe, which procedure is familiar to all wood turners. If the chuck is made comparatively shallow and the tailpiece is used to hold it in with a pad, as shown in Figure 3, it will help later in laying out.

After the ball has been proved truly spherical by testing it in various locations in the chuck, the ends of the three mutually right-angled axes must be carefully located by drawing three great circles that intersect at right angles. This can be done

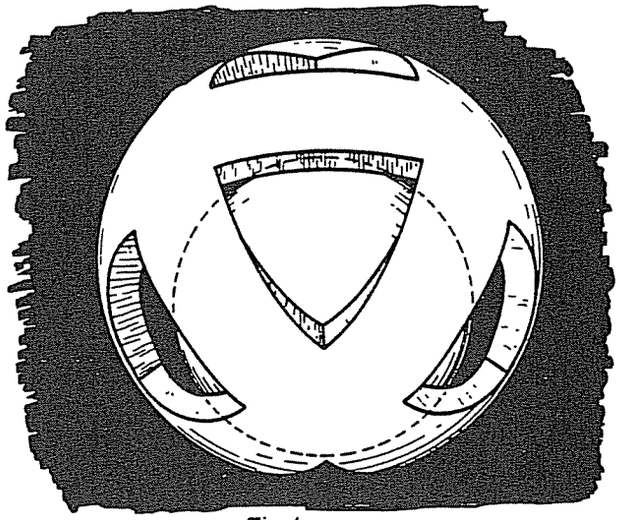


Fig 1

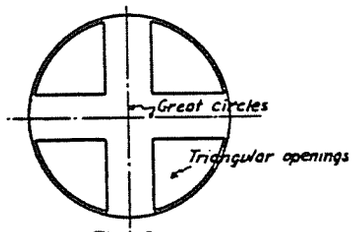


Fig. 2

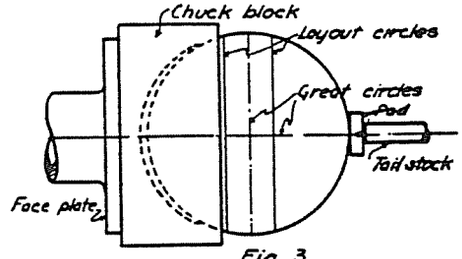


Fig. 3

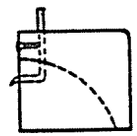


Fig. 4

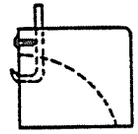


Fig. 5.

Concentric Spheres

with a pencil compass or perhaps easier by mounting the ball in the chuck as shown in Figure 3. Measuring equally each side of the three great circles, the boundaries of the eight triangular openings should be laid out as shown in Figure 2, which is the top, front, or side view, since all three would be alike.

The chuck should be deepened so that the tailstock will not be necessary, and then the center of each of the eight triangles should be bored out almost to the surface of the "inner sphere." The chuck then should be removed to use on the bench as a vise because the rest of the work must be done on the bench with hand tools. The triangles then should be worked out to their triangular outlines.

Two special routers will be needed to complete the handwork. They can be made by boring out a second wood chuck in which the sphere fits loosely. The chuck then should be removed from the faceplate and cut exactly in halves. A bottom-cutting router bit should be fitted in one of the halves as in Figure 4, and an under-cutting bit in the other. With these two special tools, a sharp paring chisel, and lots of patience and care, the inner sphere can be worked out as smooth and true as the outer one.

WOODEN PLIERS

No product of a pocketknife will attract more pleasant comment than a pair of pliers cut from a single piece of wood, nor need the maker hesitate to exhibit his handiwork for it is real proof of craftsmanship (page 44).

Making pliers should not be attempted unless one has soft, corky white pine such as is occasionally found in packing boxes. Even the ordinary patternmaker's white pine may not be spongy enough for the purpose. The blade of the pocketknife must be ground to a more slender point than ordinarily manufactured, as shown in Figure 3, or a special small chisel can be made of a razor blade or of a watch spring as shown in Figure 4. Both the knife and the chisel may be necessary as well as a number of pieces of pine before an unbroken pair of pliers is made.

A good way to begin is by splitting the wood to a rectangular shape of about the proportions of Figure 2. The splitting insures the grain being straight. A convenient size would be about $\frac{5}{8}$ by $\frac{1}{2}$ inch or a little larger. It should be whittled smooth and perfectly rectangular. Dimensions are immaterial, but proportions and accuracy are the essentials for success.

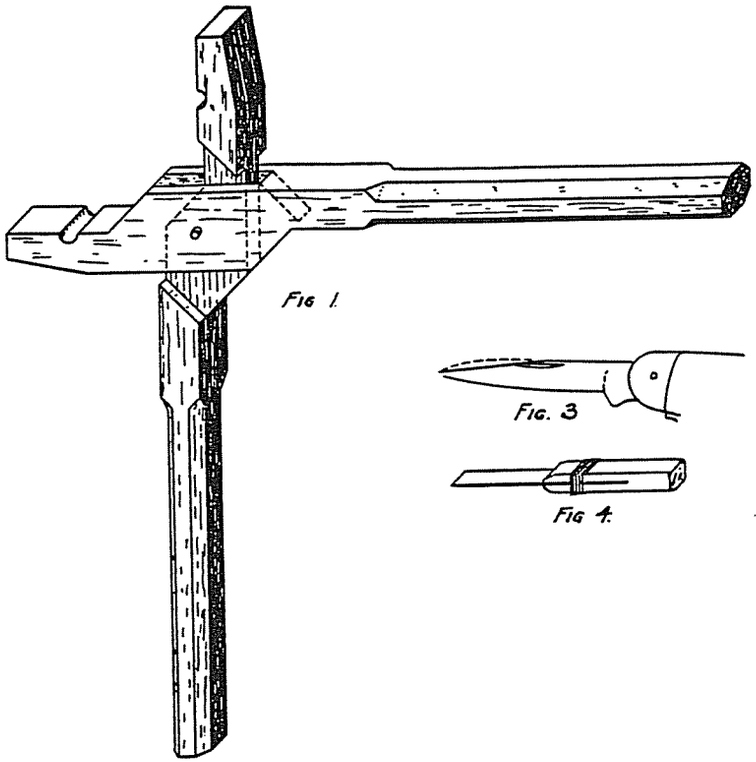


Fig 1.

Fig. 3

Fig 4.

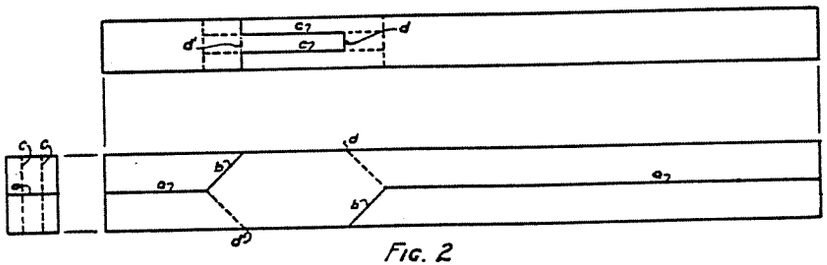


Fig. 2

Wooden Pliers

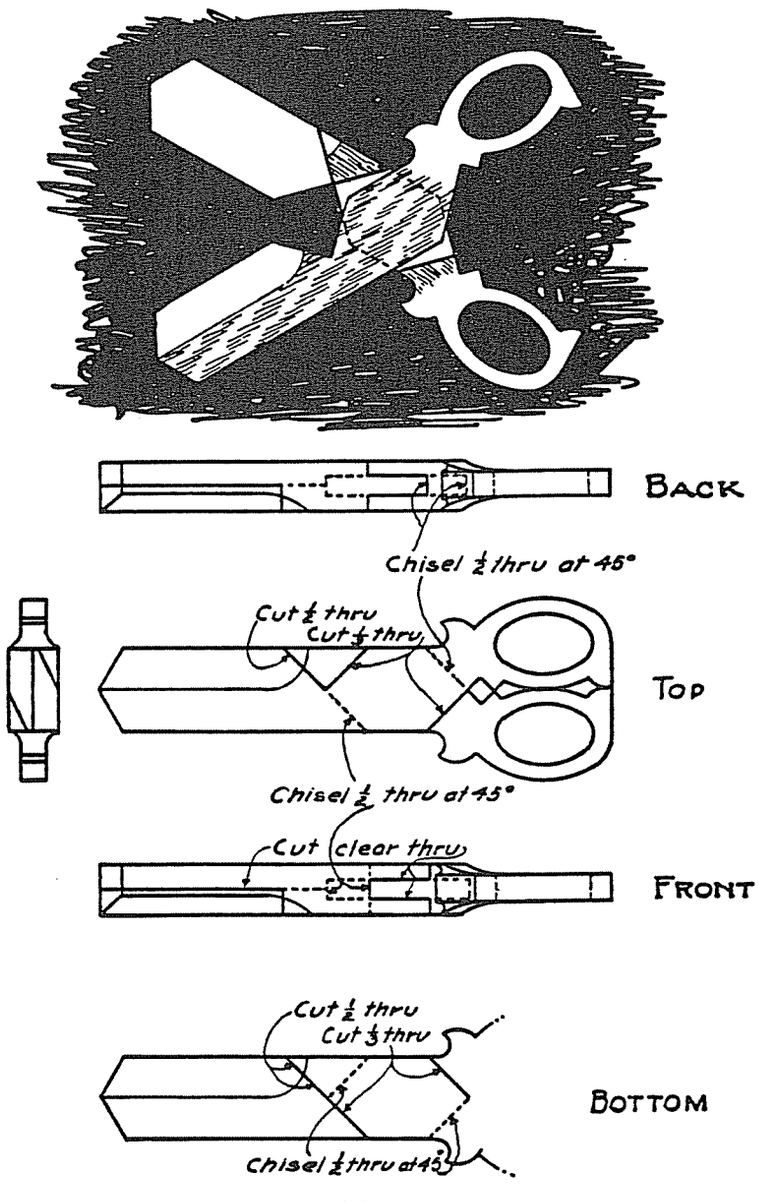
First, the piece should be scored part way through the two center lines marked *a* in Figure 2. These should be scored on both sides and ends, omitting the hexagonal space shown that should be at least twice the width of the piece.

The two 45-degree lines marked *b* should be located next. One line turns upward from the center, the other downward. If care is taken, the angle can be made accurately enough by eye. These lines should be scored lightly, and two more made *exactly opposite* on the back of the piece. These four lines should be scored to a scant third of the thickness of the piece, and these cuts must join the cuts *a* without leaving any shreds of uncut wood between.

The lines *c* should be laid off on the two narrow edges. The middle space should be slightly wider than the others — barely over a third of the thickness of the piece. The end *d* should be *exactly opposite* the end of the cut *b*. The opposite edge of line *d* is shown in the drawing as *d'*. These lines should be scored in so that ends *d* and *d'* angle in at 45 degrees toward the intersection of *a* and *b*.

This is the step where the entire piece can be ruined if not done carefully. All lines gradually should be worked deeper. Line *a* should be cut until the opposite lines meet; *cc* until they meet at the center and at the junctions of *a* and *b*, and *d* until it meets the junction of *a* and *b*. The little chisel will be very helpful, but the author uses only a pointed knife for such work.

When all wood has been cut free, the pliers will open very easily. The handles can be pared, and the jaw shaped, and an imaginary hinge pin can be inserted as shown in Figure 1. The real skill, however, is shown in cutting the pliers apart without breaking. The author has seen a real expert cut a pair of pliers with eight cuts of his knife in almost as many seconds, but eight minutes would be too fast for the author, and he would not bet on his work at that speed.



Scissors

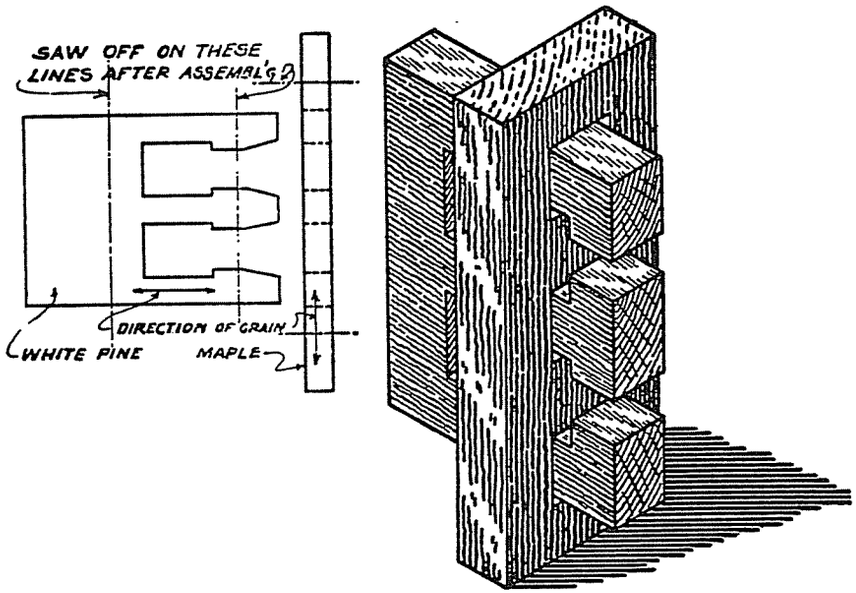
SCISSORS

A pair of scissors that can be opened and closed, cut from a single piece of wood, will attract the attention and admiration of any hobbyist, even though he thinks that all other hobbies, except his, are sinful wasters of time. The scissors, however, should not be selected as a first project in the art of whittling. After the making of the pliers has been mastered, and a little chisel suitable for cutting the box joint has been made, the worker may try to whittle the scissors. Ability to make a neat unbroken pair ought to make one eligible for membership in the most exclusive whittling club.

Soft, corky white pine is the most satisfactory wood to use for the scissors, but it must be very corky. Balsa is an excellent wood to use when learning, but it is too spongy to make a nice finished piece even with the keenest tools. About ⅜ by ¾ inch is a good size for the body of the scissors. However, the size to be made will depend on the width of the chisel that is at hand with which to cut the box joint through. The central part of the joint should be slightly over a third of the total thickness. The diagonal lines and cuts should be as near 45 degrees as can be measured by the eye. The box joint should be a little wider than the width of the piece; that is, the two lines marked *cut 1/3 through* in the top and bottom views should be a little farther apart than the piece is wide at the joint. Otherwise, there will be no space for the pieces to clear in turning. All cuts should be uniform in depth throughout and should be cut safely past all intersections of cuts, for not even a shred of uncut wood should remain or the hinge will surely break when an attempt is made to open the scissors.

E PUZZLE

The strange things that are possible with wood that has been steamed until it is soft and mushy are well illustrated in this wooden letter E which projects through holes smaller than the ends of the arms of the letter. The layout drawing shows that the ends of the E are first made long and tapered, so that after being softened by steam they may be crowded through the small holes. Forcing them through the holes will flatten them, but a little squeezing on the sides in a vise will correct this. The ends are sawed off after they have served their purpose. After the wood has dried out and hardened, few people can tell how the pieces were assembled. The E piece should be made of a soft wood like basswood or white pine, while the other piece should be made of hard, firm wood like maple or birch. Dimensions are unimportant, but it is well to know that a 7/8 by 1/2-inch piece can be forced quite easily through a 5/8 by 5/8-inch hole.

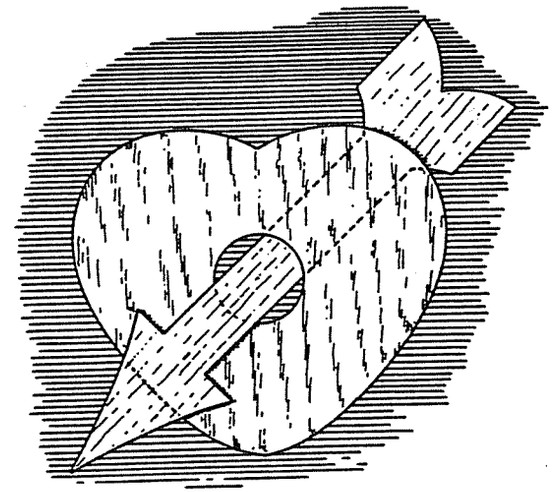


E Puzzle

WOODEN VALENTINE

An examination of this wooden valentine will prove that the cupid's dart cannot be removed from the heart it has pierced, unless the sender reveals how he was able to get the arrow through the opening in the heart. A variation of this valentine would be to have the arrow pierce two hearts.

The heart and the arrow are made of thin pieces of wood, about 1/8 inch thick, and preferably of contrasting colored woods. The arrow should be of a soft wood like basswood or white pine to be the more easily worked. The secret of getting the large arrowhead through the smaller hole in the heart is to thoroughly steam the arrow, which will make it so soft and pliable that it can be rolled up, put through, and unrolled to dry hard.



Wooden Valentine

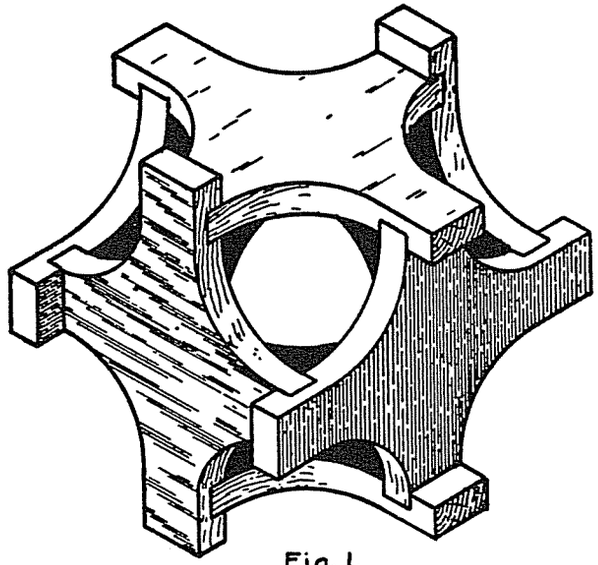


Fig. 1.

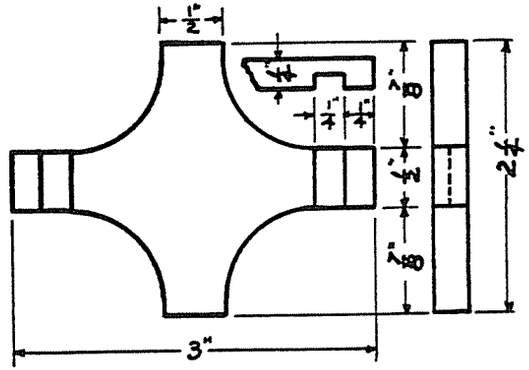


Fig. 2

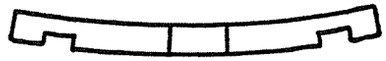


Fig. 3

Draftsman's Dream

DRAFTSMAN'S DREAM

If you doubt that this is something that none but a draftsman could build — and only on paper — just start figuring how to take it apart. Begin anywhere, for all six pieces are alike and are held in place identically. Of course, it cannot even be put together in the first place!

Wait. Suppose the six pieces were first laid inner face down in a little water until they warped and expanded a little. Wouldn't they go together then? So easy, it almost spoils the fun.

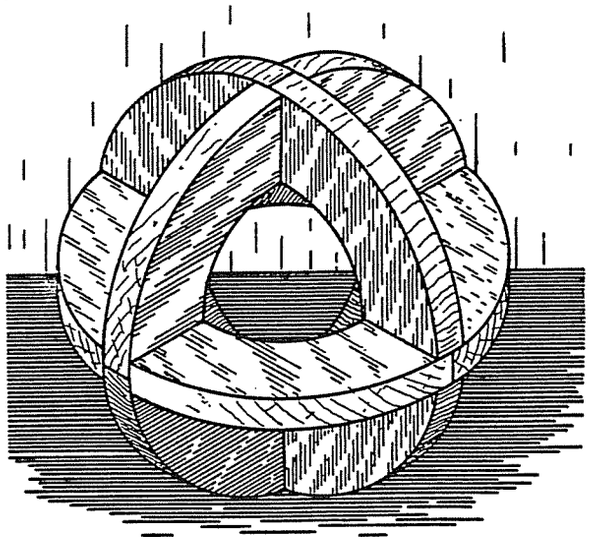
Another way to make the puzzle is to have the grain run lengthwise of the pieces and not crosswise as shown in Figure 1. Make the 2¼-inch dimension a little scant by shaving off one piece after another until the six pieces can be forced together. This will make quite a rickety assembly suggestive of a dried-out wagon wheel with all fellies and spokes loose. Now treat your "dream" like farmers treat their loose wagon wheels by swelling them in hot linseed oil until all pieces swell tight. The oil will oxidize and leave all pieces enlarged and fitting as tight as the draftsman drew them.

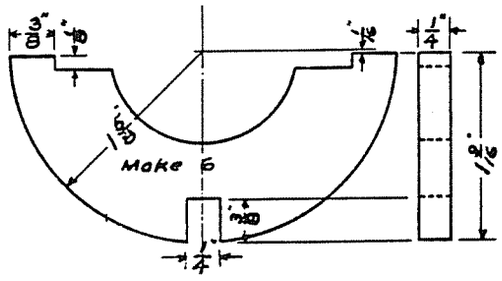
How to get it apart? The draftsman awoke before he got that far.

SIX-PIECE BALL PUZZLE

This is a one-way puzzle, for there is no way of taking it apart once it has been properly constructed, except to destroy it. But, that makes it all the more of a challenge to one who thinks he knows all about how to put wood pieces together. He can see how to put the first five pieces together but not how to add the sixth piece. But, there is a way, and such a simple one as to almost spoil the challenge to make it. The solution is one that those who see the finished article will be very slow to suggest as the means by which it was put together (page 52).

The pieces are not full half circles since 1/16 inch has been shaved off the chord side. This leaves enough play so that the pieces can all be forced into place, but it does leave the assembly





Six-Piece Ball Puzzle

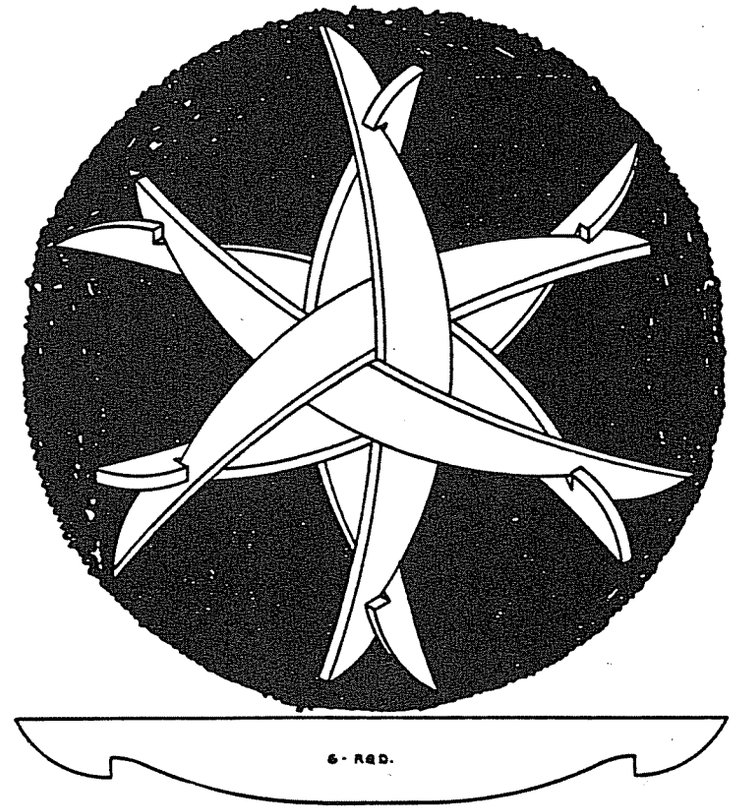
so loose that it can be taken apart and seems crudely made. The assembled piece then should be soaked in linseed oil, preferably hot, until it all swells tight — just the way farmers tighten loose wagon wheels — and it will never come apart without being cut apart. It is just as well if it has a little play because that proves that it must have been put together some way.

This is the author's contribution to the proper disciplining of those who think they know all that there is to know about assembling several pieces of wood.

THE COCKLEBUR

This creation of the author's is quite a stunt to put together. The notation in the drawing that but six pieces are required doesn't include the number of pieces broken in trying to spring them into place, nor does it include those strips of wood broken while experimenting on the amount of bending each will stand. Of course, the fun is in springing them all they will stand for.

The author has long wanted to make a cocklebur of green sapwood basswood to see what a thoroughly bent one would look like, but he has had only dry material at hand, as most



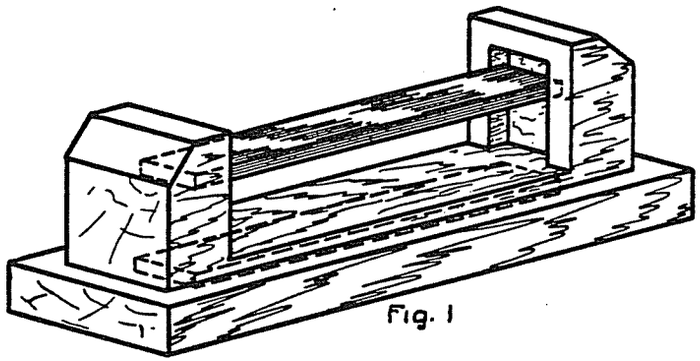
The Cocklebur

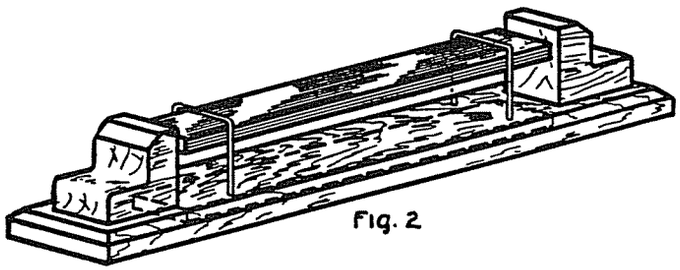
readers will have. No dimensions are given, as it will be necessary for each craftsman to adapt the size of the pieces to the material he has on hand. The cocklebur shown in the illustration was made of 1/8-inch wood. The width and length were made as large as possible while still permitting the pieces to be bent without breaking.

THE FLOATING MAGNET

Yes, it floats on the air with the greatest of ease,
Like the lauded young man on the flying trapeze.

A piece of metal that defies all the laws of gravity and persists in floating, to all appearances, unsupported in the air, will attract the attention of anyone. It will quite likely leave the spectators unsatisfied as to how and why, except a few who remember that magnets do not always attract iron and steel





Floating Magnet

but always *repel* like poles of another magnet as powerfully as they attract its unlike poles. To those, it will be evident that there is a magnet, similar to the floating one, buried unseen in the wood. The answer is so simple, when explained, as to almost destroy one's interest, but not every spectator has had a course in physics and most of those who did, have forgotten most of it. Not many people will know why the metal bar floats if the workmanship is good enough to conceal the buried magnet.

If this novelty is made as in Figure 1, the top of the wood piece rather naturally covers the recess for the buried bar and adds a slight puzzle as to how the bar was inserted in the recesses in the ends of the upper piece of wood. It is, of course, done by bending the flexible middle part of the wood and snapping the bar into place before the piece is fastened in place on the base.

Figure 2 is a simpler construction. It was made by Thomas Thomason of Astoria, Oregon, who sent the project to the author. The wires shown in the drawing are of copper or brass; therefore, they will not become magnetized by being in the magnetic field.

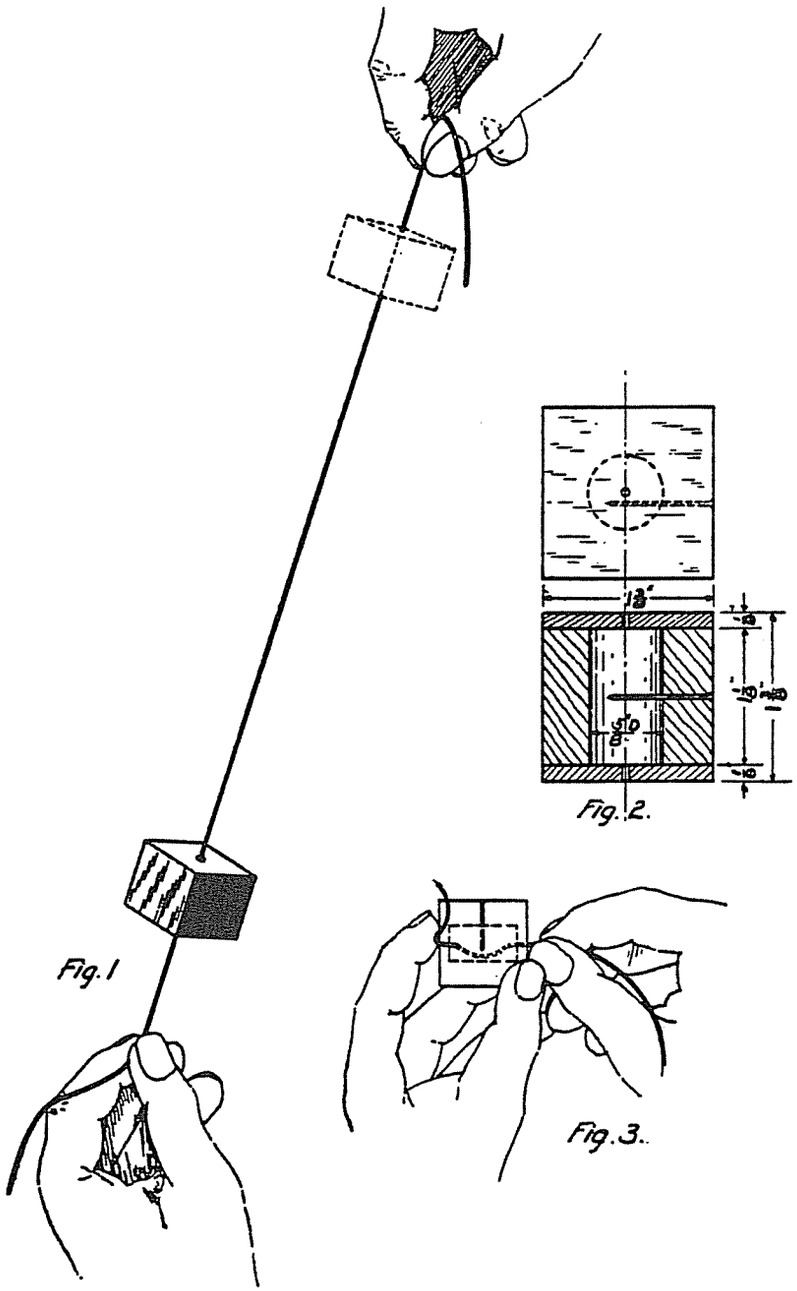


Fig. 1

Fig. 2.

Fig. 3.

Mysterious Block

THE MYSTERIOUS BLOCK

This simple looking block of wood has the mysterious quality of either sliding freely on the tight line, as shown in Figure 1, or of stopping anywhere its owner wants it to on its downward glide. Quite evidently the control is by the tension on the line, but it won't stop, as it evidently should, in the hands of others, like it does for the owner!

Figure 2 shows that the block isn't a simple solid piece as it appears, but is made up of three pieces glued together. The middle piece has a large hole bored through it, and the other two have small holes just large enough for the string to slide through freely, as the drawing should make clear. A small nail sticks through a side into the central chamber or hole in the middle piece. This nail enters the hole a little past the center of the block and a little to one side of the center. The nail is the secret of what makes the block stop when the cord is held tight. That is, the block will stop when the cord zig-zags behind the nail; it doesn't when the cord goes straight through.

Now, the secret is revealed on what stops the block, the next question is, "how to get the cord behind or free of the nail." Figure 3 shows how this is done, as follows. The left forefinger holds the cord from moving at one side of the block. On the other side the right finger and thumb grasp the cord a little from the block and push it inward, making it bow inside the block. Then the thumb and finger twist the cord and throw the bow over (or off) the nail. Of course, it all has to be done apparently casually and without focusing attention by looking while detracting attention by patter.

These are helpful suggestions: Have some mark, like a dubbed-off corner to feel the most advantageous position of the block for throwing the loop on or off. Paint the block to cover the joints so that its construction may not be revealed. Use a braided rather than a twisted cord to prevent its kinking.

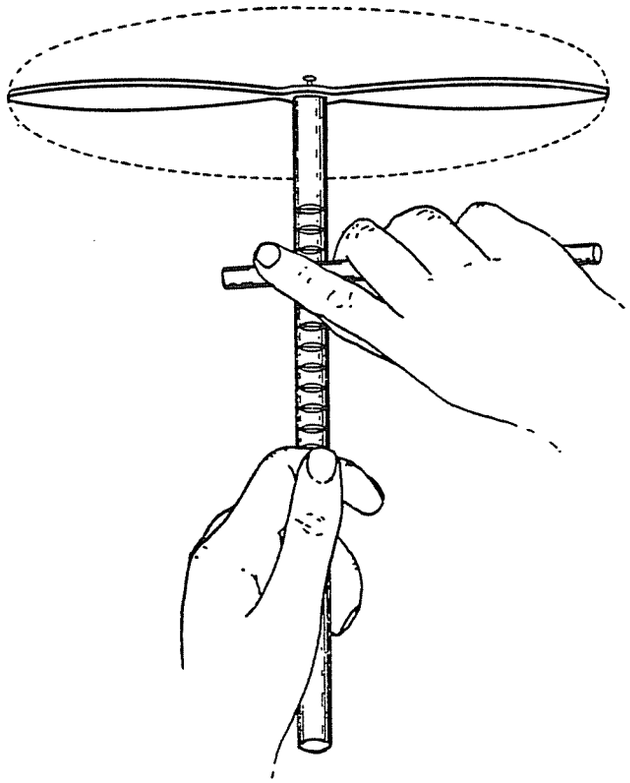
This mysterious block is the invention of Robert E. Rice of Houston, Texas, who makes puzzling things like this when he gets bored at opening locks for people who lose their keys or forget combinations.

THE LIE DETECTOR

This little project can contribute quite a bit of entertainment to a group if the operator knows the secret of making it work.

The rod should be held so that the first two fingers of the right hand straddle the notched stick. By letting first one finger, then the other, rub along a side of the notched stick when the rod is stroked up and down, it will be discovered that the propeller will spin in different directions depending upon which finger rubs the stick.

The entertainer can now ask the members of his audience to answer questions. He can make the propeller spin to the right for truthful answers. But, if he wants to make it appear that the answer is a falsehood, he can reverse the action of the propeller by using the other finger.



The Lie Detector

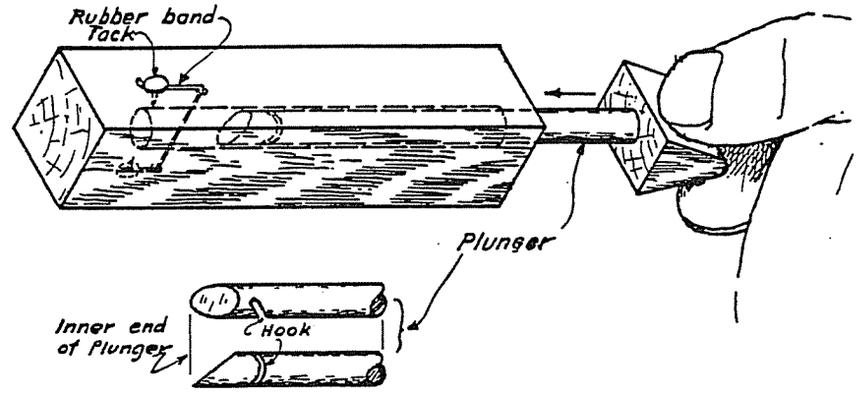
FAKE POP GUN

No, this isn't a pop gun, although it does go "pop" when I pull the plunger out and let it fly back. When I pull it clear out, you see that there is a little hook on the inner end; also that a rubber band goes through the barrel. You simply insert the plunger and hook it onto the rubber. Then, when you pull it out and let it go, the rubber pulls in with a pop. You want to try fishing for the band? Go ahead!

What, you cannot make it work! Must be you are using the wrong bait. Watch me. It is so easy. "Pop, Pop! Pop!!"

Nothing makes one feel quite so foolish as inability to do something that looks too simple to challenge an infant. But, the rubber band and hook are camouflage. The plunger pops in because the wedge on its outer end is squeezed between the thumb and finger until it flies out and pops against the other piece. The rod of the plunger is too short to even reach the rubber! The plunger must be so entirely free in the barrel that there is no possibility of it binding.

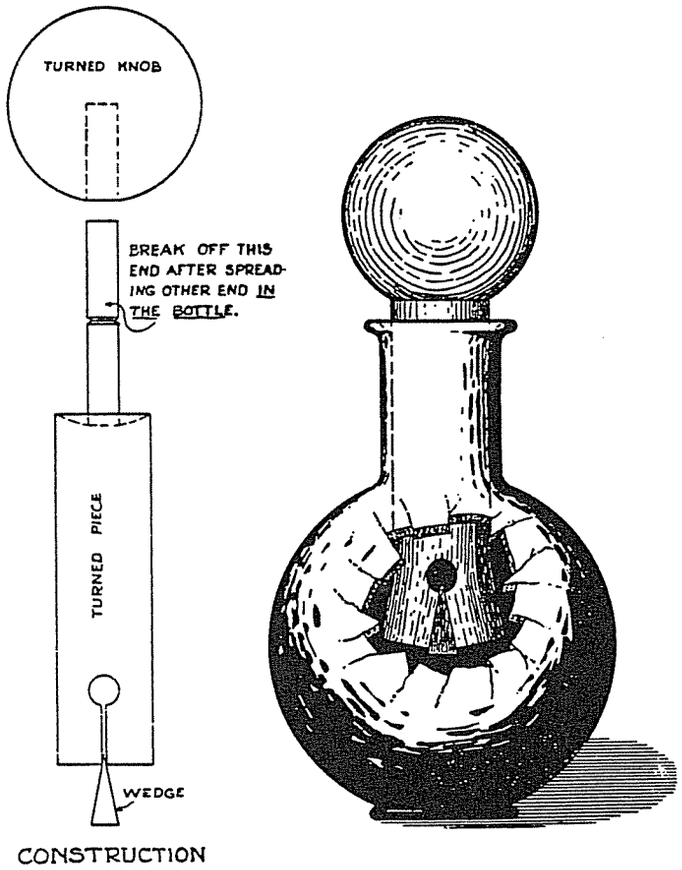
Dimensions are unimportant, but the wedge-shaped handle must be sloped enough so that it will slip from between the fingers when squeezed tightly. It can be shaped by trial, or even be greased a little.



Fake Pop Gun

PLUGGED BOTTLE

All chair builders are familiar with the method of spreading the end of a rung in the bottom of a dovetailed hole. This is done by starting a wedge in the end of the rung, letting the bottom of the hole force the wedge into the rung, and spread it as it is driven home. However, this worth-while joint does not seem to be very well known to other woodworkers. This method is used in plugging the bottle shown here. If the turned plug were left long enough to reach the bottom of the bottle, the method of driving the wedge into place would occur to most



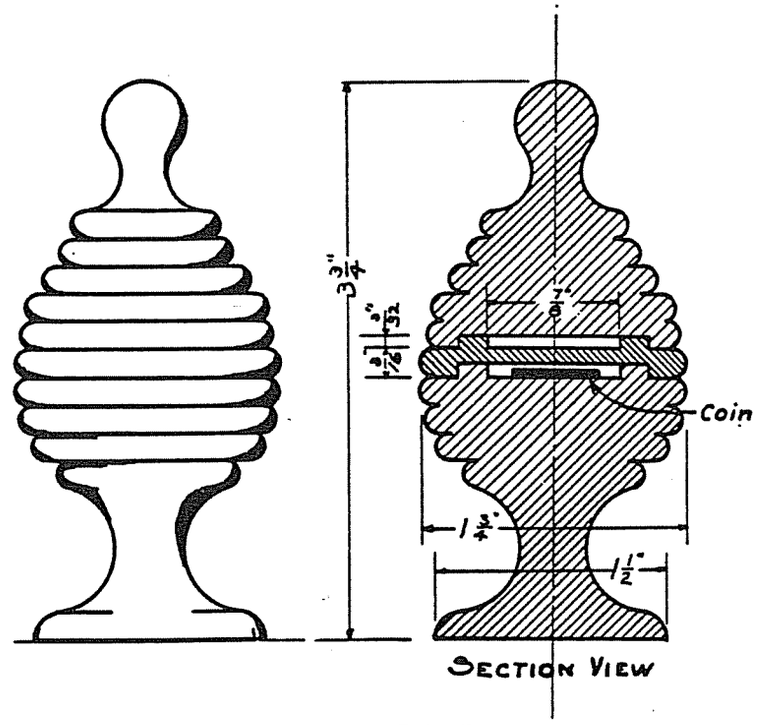
Plugged Bottle

people, so, to cover one's tracks, it is expedient to cut the plug off short and seat the knob close to the bottle. The plug could be fastened into the knob by a chair-builder's joint after gouging the hole in the knob larger at the bottom. But, trial will prove it to be easier to glue the knob in place, since it would be difficult to get enough pressure in seating the knob to spread the wedged end.

DISAPPEARING COIN DEVICE

This innocent appearing turned piece that looks like a furniture finial has infinite possibilities to confound and chagrin anyone who will contribute a coin to help illustrate how it works.

Study of the section view will show that it is turned in three pieces. These pieces are loose fitting on the inside but look tight about the outside.



Disappearing Coin Device

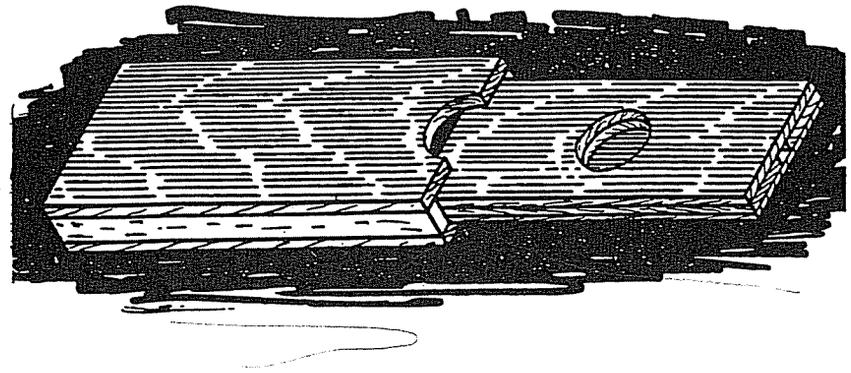
The entertainer grasps the device at the middle and lifts off the two upper pieces, disclosing an opening in which he asks someone to place a coin. He replaces the two upper pieces without revealing that there are more than two pieces to the device. After some hocus-pocus, perhaps covering it with a handkerchief, someone is asking to lift off the lid which he will naturally do by taking hold of the knob. Only the top piece lifts, leaving the coin between the two bottom pieces. Apparently the coin has disappeared.

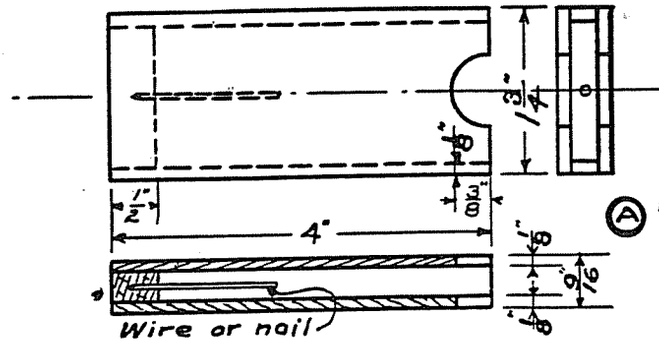
COUNTERFEIT MACHINE

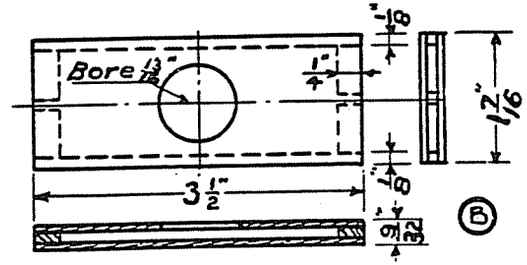
The wonder of this machine is not that it makes nickles out of lead, but that it apparently changes the good dimes of an inquisitive acquaintance into nothing; or, if you feel better about pocketing his dimes, it will change them into your pennies. Even though you do not keep his dimes, you can have fun by making him hunt or ask for them.

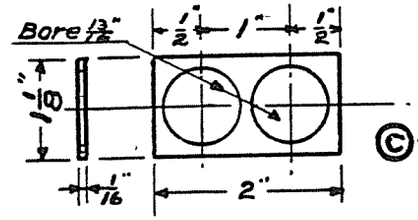
Part A is a simple box, open at one end, and part B slides into it, either end first. There is a coin-shaped hole in the top at the center in B. If a coin is placed in this hole, and the two parts are slid together and then pulled out again, the coin disappears or changes to a different coin. If, however, the slide is *reversed* and put through the same operations, the original coin reappears.

The answer to this trick is that the slide B is hollow and has inside of it a piece with two holes in it, shown as C in the drawing. This inner piece C can be slid back and forth so either hole is directly under the one hole in B. As shown in the drawing of B, there is a small hole in each end of it. A wire is inside of piece A. When B is slid inside of A, the wire enters the hole in B and pushes the piece C along so that it places a different hole under the hole in B. It is this sliding motion that changes the dime to a penny, or simply makes it disappear.









Counterfeit Machine

DOMINOES

There isn't a nicer woodworking project for a real craftsman than a set of dominoes with dots and division bars made of bits of wood that contrast with the body pieces. The contrast must be marked for ease in playing; however, the body

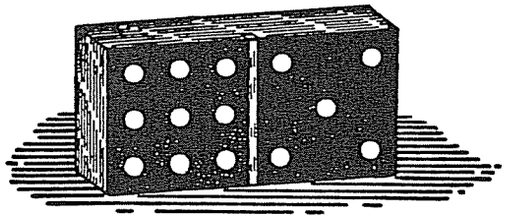


Fig. 1

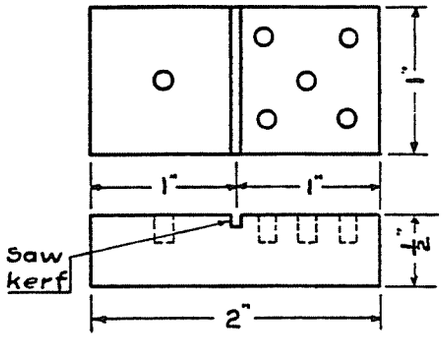


Fig. 2.

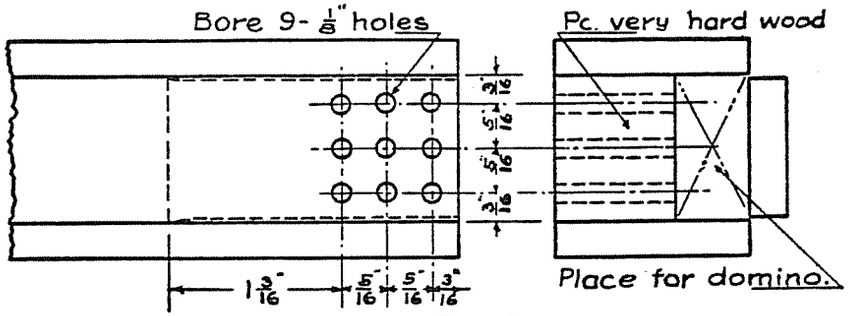


Fig. 3.

Dominoes

parts should not have so much grain marking as to permit identification of different pieces.

Dark ebony body and white holly dots make ideal dominoes when such woods can be obtained. If much grain or sap marks the body wood, however, pieces should be stained black, and even if this is not needed to obliterate marking, it helps to heighten the contrast with the light-colored dots. Of course, the staining should be done before gluing in the dots.

The blocks should be cut, kerfed, and bored as shown in Figure 2. The bar for the kerf may be of less contrasting wood than that used for the dots. The holes for the dots can be bored in a boring jig, as shown in Figure 3. The blocks can be made with 18 holes instead of 9 as shown and so save reversing the dominoes when they are being bored.

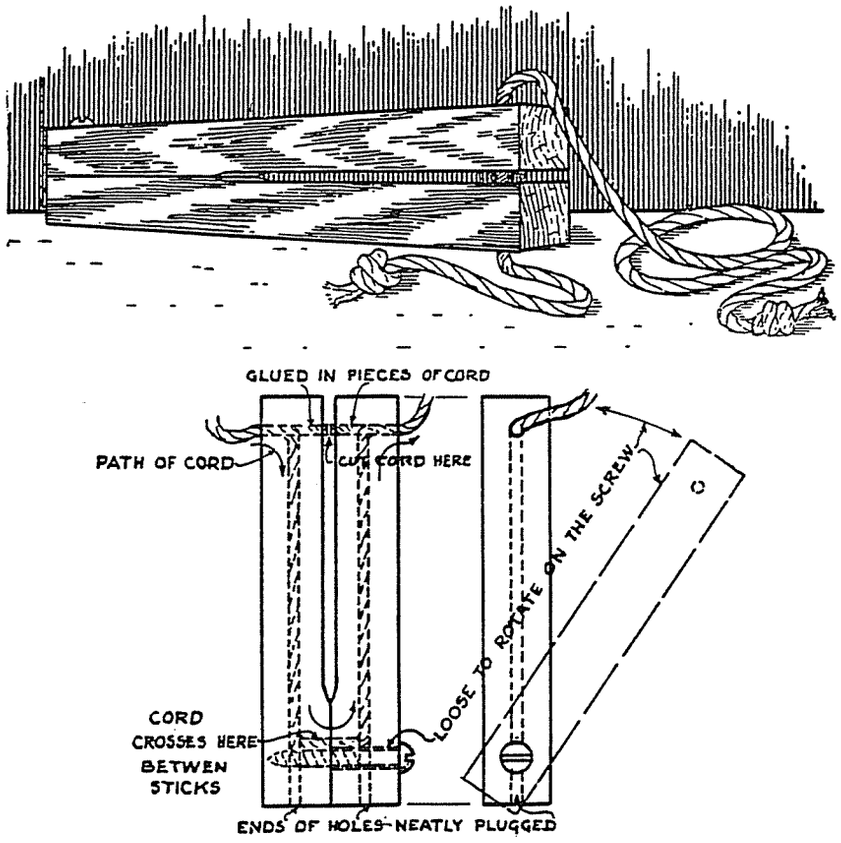
If dowel rod of light-colored wood can be obtained for the dots, excellent dominoes can be made. The author always had to make his dowels in a dowel plate, or by turning out frustums of cones in a drill chuck in a lathe. Colorless shellac or varnish should be used for finishing so as not to darken the dots for, being end grain, they will soak up considerable finishing material.

When the dominoes have been made, a dovetailed box with inlaid or carved exterior should be made to keep them in. This set will then qualify to some day become a valuable heirloom.

STRING PUZZLE

Show a friend how the string pulls back and forth as you pull first one end, then the other. Place a knife blade between the sticks, and cut the string (your friend won't notice that it had been cut before). After cutting (?), the string will still pull back and forth as before, in your hands. After saying "hocus-pocus," however, and passing the puzzle behind your back, your friend will be surprised to find that the string will not pull either way in his hands!

The working drawing shows that the string does not go directly through the sticks as it appears to, but down a hole in the center of one stick to where it crosses next to the screw and comes up the center of the other stick to the exit hole. A glued-in bit of string in each piece is left to be cut (?). The other piece of hocus-pocus is that as you pass the puzzle behind your back, you completely revolve one stick about the screw, which winds the string about the screw.

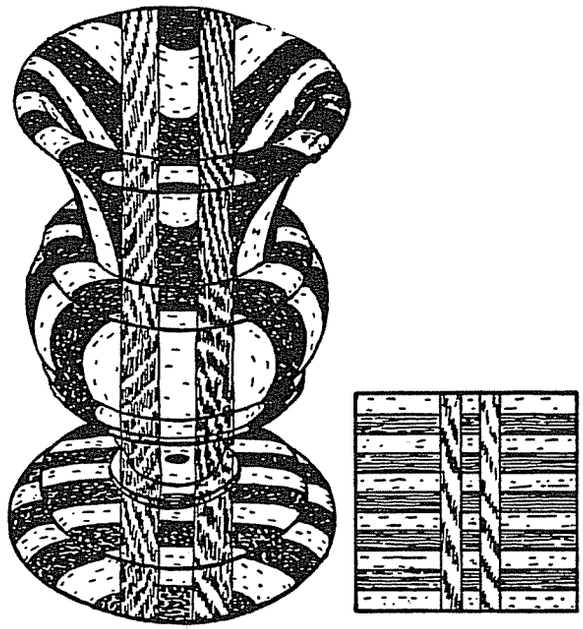

GLUED IN PIECES OF CORD
PATH OF CORD
CUT CORD HERE
LOOSE TO ROTATE ON THE SCREW
CORD CROSSES HERE BETWEN STICKS
ENDS OF HOLES NEATLY PLUGGED

String Puzzle

BUILT-UP TURNED WORK

Many amateur craftsmen who have learned to do wood turning are not aware of the striking effects that can be produced by turning stock glued up from contrasting colored woods.

This vase is an example of the result of turning a piece made up of three kinds of wood. Alternating pieces of walnut and holly were first glued together, then ripped in two places and oak set in, and all reglued as shown in the lower illustration. An odd number of alternating pieces were used. This is quite important and likely to be overlooked the first time one tries the stunt. It insures the stripes producing a symmetrical pattern on the finished article. Obviously, unusual care must be observed in centering such a piece of stock in the lathe. No matter how careful one is, he is quite sure to wish he had been even more careful when he watches the piece shape up.



Built-up Turned Work

ROPE BORDER

Amateur woodworkers often admire parquetry, try to estimate the number of pieces of which it consists, and marvel at the patience of anyone who would glue so many little blocks together. But, they do not realize that it is a matter of knowing how, more than minute accuracy and patience, that accomplishes the results they admire.

Explanation of one of the most common parquetry borders, the rope, will show that, though it will take time, it is not a highly skilled operation, and anyone with reasonable skill and tools can use it in his cabinetwork.

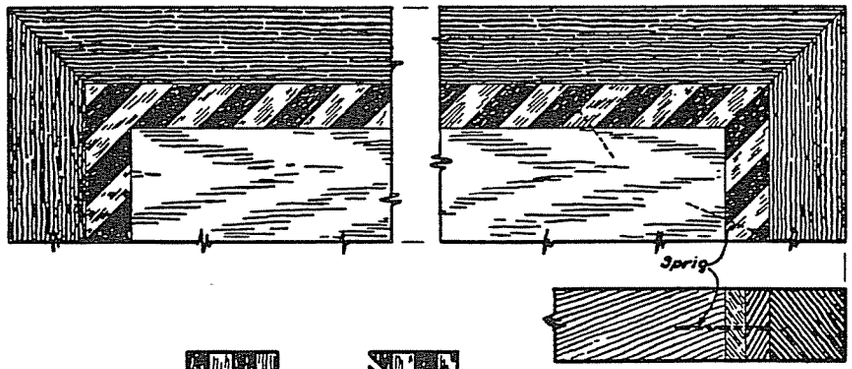


FIG. 1.

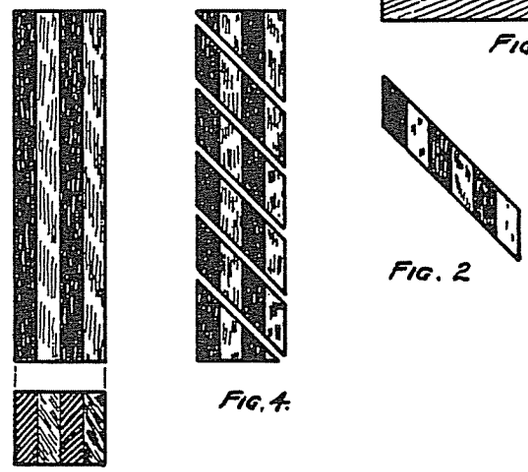


FIG. 3.

FIG. 4.

FIG. 2

Rope Border

The rope is usually made of alternating diamonds of light and dark wood, as shown in a corner of a table top in Figure 1. It can, however, be made up of several kinds of wood repeating themselves in a series as illustrated in Figure 2.

The first step is to glue an equal number of alternating kinds of strips of wood together as in Figure 3. After the glue has hardened, this assemblage of strips is cut to 45 degrees in a miter box, as shown in Figure 4. To insure their being cut to a uniform size, a stop block must be used in the miter box. Then these blocks, all alike, yet made up of several blocks themselves, are glued in place. If the article is made with the parquetry extending through as in Figure 1, each assembled block can be bradded and glued in place and the mitered outside piece glued on still later. Sometimes this rope border is inlaid in a groove or the whole built-up work is glued onto a plywood base. The making of the rope is the same, no matter how it is applied.

MARQUETRY

Every woodworker who dares to attempt the new is sure some day to try his hand at marquetry, or pictures in wood. With enough assortment of different kinds of woods, most convenient if in veneers, he can produce some striking effects. Following are some helpful suggestions for doing this work, yet they are not so complete as to spoil the fun by telling all.

The shrinkage and expansion that take place in different kinds of wood should not be overlooked, otherwise the finished product may become badly warped. A thick plywood backing is one solution against warping, and a heavy frame built around the marquetry picture is another solution.

In building up the picture, first one piece can be cut out and then its neighbor scribed to fit it, but it usually is better to cut both pieces, or perhaps several at a time, as shown in Figure 3, even though it wastes material. Thus, the three dif-

ferent pieces of veneer being cut in Figure 3 may be for the two doves and the background shown in Figure 2. After the three different kinds of wood had been copesawed alike, to the

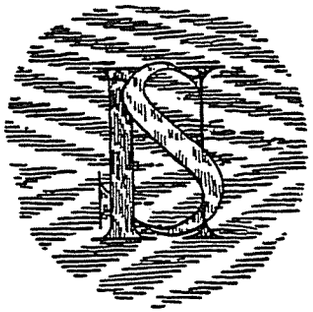


Fig. 1.

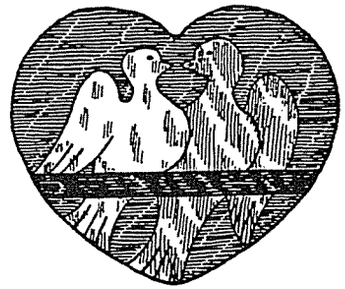


Fig. 2

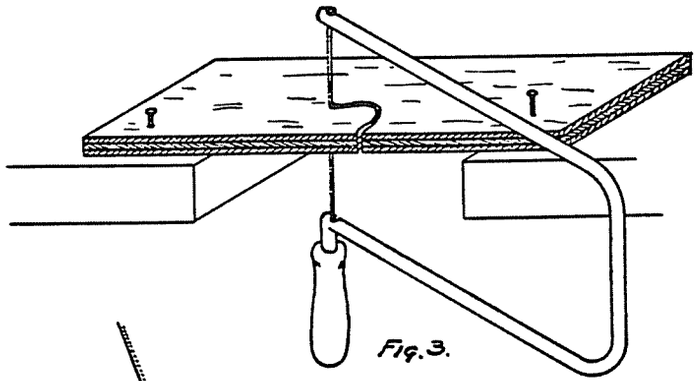


Fig. 3.

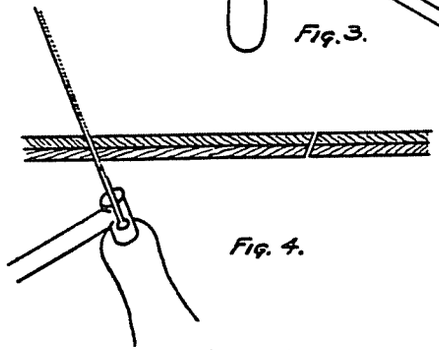


Fig. 4.

Marquetry

correct outlines of the different parts of the picture except the perch, a piece of one veneer would be selected for one dove, another from the second kind of veneer for the other dove, and the piece for the background from the third piece of veneer. After the several parts had been glued to a plywood back, the piece for the perch could be cut out by scribing. The feathers could be suggested by knife-scored lines or with saw kerfs. Often expensive plywood can be saved by making parts not to be used of some of the layers of cheaper plywood or even cardboard of the same thickness.

The most satisfactory cutting can be done with a fine jeweler's saw, because it cuts a very narrow kerf. Also, a jeweler's saw has no loop or pin on its end and, therefore, can be started through a small awl or drilled hole. Where a coarse coping saw has to be used, the pieces can be cut with a taper as suggested in Figure 4. This is especially easy where the stock is thick and the worker must saw his own veneer.

Sometimes it is practical to make wide saw kerfs a part of the design as in the monogram in Figure 1. Parts of these letters are wide sawed lines which are filled with lamp black and paste filler after the pieces have been glued on, giving an effect such as artists often achieve by outlining colored elements of a conventional picture with heavily inked lines.

Where thin veneer is used, the pieces should be assembled by sticking them on the *face* side to a sheet of paper, and then gluing the whole assembly at one time to the backing, using cold glue and a veneer press or its equivalent.

Where unusual colors are required by the design, minor parts can be stained after gluing, scraping, and sanding.

Sand paper should not be used for leveling the surface, because the softer woods will cut faster than the harder, and the glue joints will cut very little, if at all. A cabinet scraper should be used very carefully, and sanding should be done very lightly with paper *glued* to a carefully leveled block. The entire surface should be touched up by stroking each piece lengthways of the grain with a rolled piece of the finest sandpaper.

Wonderful texture effects often can be produced by selecting pieces for their texture and grain.

Occasionally foreground figures are overlaid, making a relief the thickness of the veneer. It gives perspective and is easy to do, by simply gluing the pieces over the inlaid background.

The frontispiece in this book is a fine example of what can be done in marquetry.

GEOMETRICAL OR CHIP CARVING

When manual training had developed in our schools beyond the joint stage to include interest and art considerations, every young craftsman learned to ornament his work with geometrical carving. Now, however, the author learns with some surprise that many students and most home craftsmen know nothing of the possibilities of ornamenting wood by this interesting method.

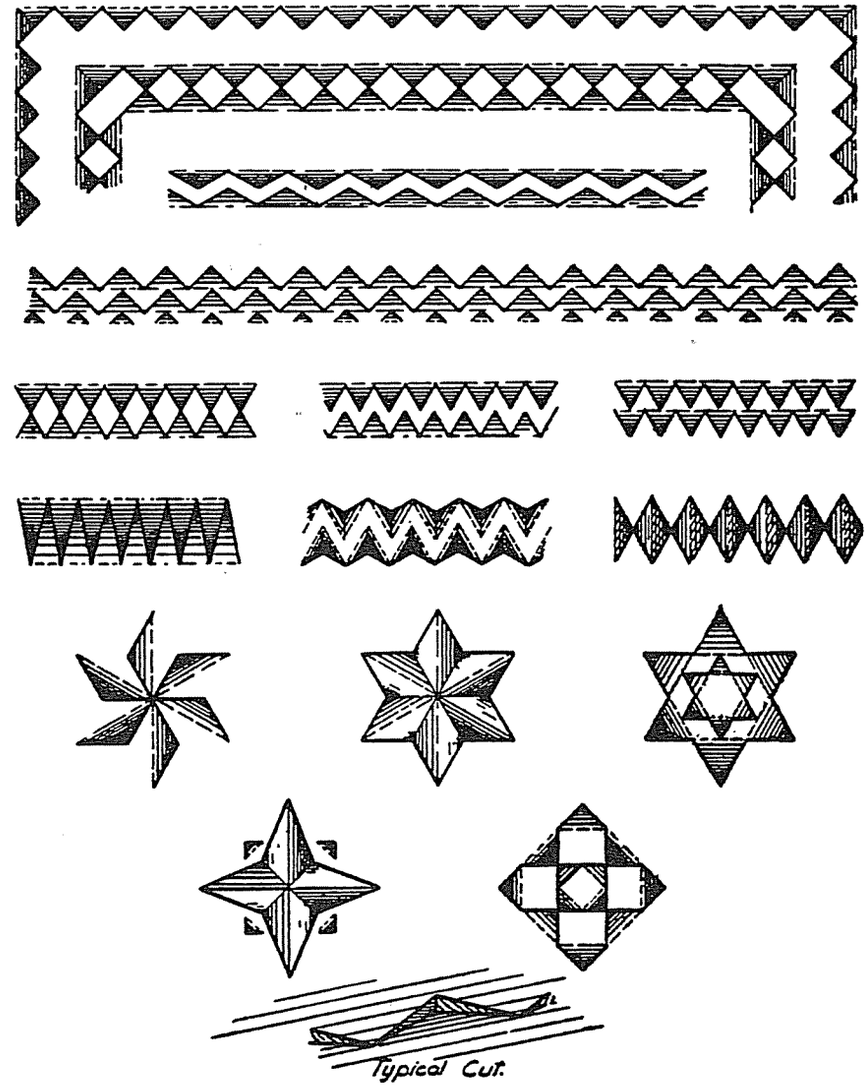
In the accompanying drawing enough designs are shown to give a beginner a variety from which to make his choice for his first efforts. With a sheet of cross-sectioned paper, or a drawing board, endless variations can be worked out.

A really striking effect can be produced by sealing and painting the wood and then carving through the painted surface. The wood must be well sealed and the paint worked thin and then shellacked or varnished over all. However, it is better to begin carving on unfinished wood.

The designs should be laid out on the wood with a pencil and a T bevel or drafting triangles. Care must be taken to insure that the corners work out evenly, or can be turned at all without changing the design.

The carving can be done with a pocket or bench knife, but it is much easier with a carver's skew chisel or a regular chip-carving knife. The author has made a very acceptable knife by grinding a broken kitchen knife to a chisel end skewed about 30 degrees from the normal cutting edge of a chisel.

The cuts are all made triangular, from ¼ to ½ inch on a side. First, two sides are cut down as shown in the Typical Cut in the drawing, and then the bottom is pared out with a single cut; three cuts to a triangle.



Geometrical or Chip Carving

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